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SOME ASPIDIOTINE SCALE INSECTS WITH ENLARGED SETAE ON THE PYGIDIAL LOBES (HOMOPTERA : COCCOIDEA : DIASPIDIDAE)

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Abstract

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Aspidiotines with lanceolate setae on the pygidial lobes are revised and referred to *Octaspidiotus*, which now comprises 9 species from Australia and Asia : *O. subrubescens*, *O. calophylli*, n. comb., *O. stauntoniae*, n. comb., *O. tripurensis*, n. sp. (from India and Thailand), *O. tamarindi*, n. comb., *O. nothopanacis*, n. comb., *O. machili*, n. comb., *O. multipori*, n. comb., and *O. australiensis*. The species newly transferred to the genus were originally described in *Aspidiotus*, and three of them were later referred to *Metaspidiotus*, which is now united with *Octaspidiotus*. Two other species originally described in *Octaspidiotus*, *O. araucariae* and *O. caledonicus*, are removed from the genus, and a new genus, *Oceanaspidiotus*, is erected to accept them and *Aspidiotus spinosus* (= *Acanthaspidiotus borchsenii*, n. syn.). The occurrence of the 4th pair of pygidial lobes in *Octaspidiotus*, *Oceanaspidiotus*, and *Aspidiotus* is discussed, and it is shown that the forms with 4 pairs of lobes are distributed in the zoogeographical region Notogaea.

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Contents

1) Research Trips for Agricultural and Forest Insects in the Subcontinent of India (Hokkaidô University, University of Calcutta, and Zoological Survey of India Joint Project) [Grants-in-Aid for Overseas Scientific Survey, Ministry of Education, Japanese Government, 1978, No. 304108; 1979, No. 404307], Scientific Report No. 16.

2) Scientific Results of the Hokkaidô University Expeditions to the Himalaya, Entomology No. 46.

INTRODUCTION

In the course of my study on scale insects which I collected in the Indian Subcontinent I came across 3 species referable to *Metaspidiotus*, while this genus had been represented by 3 other species occurring in the Far East. I identified the South Asian species with ones which were originally described in *Aspidiotus*. Authors who described or redescribed them all failed to notice the occurrence of lanceolate setae on the pygidial lobes, a character peculiar to *Metaspidiotus*. This led me to examine other species which I supposed, on the basis of the literature, to be more or less similar to those species referable to *Metaspidiotus*. To my surprise though not wholly against my expectation, lanceolate setae occur in the Australian *Octaspidiotus subrubescens*, the type-species of *Octaspidiotus*. On my close examination I have concluded that *Octaspidiotus* MacGillivray, 1921, and *Metaspidiotus* Takagi, 1957, should be united. I also found lanceolate setae to occur in another species from China. Thus, at least 8 species among the described aspidiotines should be referred to *Octaspidiotus* understood in the new concept. On this occasion, 1 new species is also described as a member of the genus on the basis of material collected in Thailand and eastern India and sent to me for study.

On the other hand, 2 other species originally described as belonging to *Octaspidiotus* should be removed from the genus. I will propose a new genus to accept them and *Aspidiotus spinosus*. The last species is problematical as to its bounds. It is tentatively interpreted as a variable species, including *Acanthaspidiotus borchsenii* as one extreme of the variation.

It is an unbelievable fact that the lanceolate setae have easily been overlooked by authors. The confusion encountered, however, is also due to failure in evaluation of characters. Since MacGillivray's notorious work the number of pygidial lobes has been much weighed in forming genera. Thus, *Octaspidiotus* has been understood as having 4 pairs of lobes. In the course of my recent studies on some aspidiotines I have been convinced that there is no good basis for any prejudgement based on the number of pygidial lobes in recognizing genera. However, the number of lobes itself must have an evolutionary significance as will be discussed.

OCTASPIDIOTUS

Type-species: *Aspidiotus subrubescens*.

Octaspidiotus MacGillivray, 1921, The Coccidae, p. 387 [type-species: *Aspidiotus subrubescens*]; p. 395 [key to 4 forms transferred from *Aspidiotus* to *Octaspidiotus*: *O. atherospermae*, *O. "subrubescens corticoides"* (=*Aspidiotus subrubescens* var. *corticoides*), and *O. furcillae* besides the type-species].

Octaspidiotus: Ferris, 1937, Microentomology 2: 55 ["Probably a valid genus"].

Octaspidiotus: Borchsenius, 1966, A Catalogue of the Armoured Scale Insects (Diaspidoidea) of the World, p. 272 [*O. araucariae*, *O. australiensis* (=*Aspidiotus australiensis*), *O. corticoides*, and *O. subrubescens* included in the genus].

Metaspidiotus Takagi, 1957, Insecta Matsumurana 21: 35 [type-species: *Aspidiotus stauntoniae*; *A. multipori* also transferred to the genus]. New synonymy.

Metaspidiotus: Takagi, 1969, Insecta Matsumurana 32: 91 [redescribed; *Aspidiotus machili* transferred to the genus].

Composition. As employed by the original author this genus included 2 species

in addition to the type-species and a supposed subspecies of the type-species, all transferred from *Aspidiotus*. One of them, *O. atherospermae*, was later synonymized by Ferris (1941) with *Aspidiotus hederae* and, therefore, should be retained in *Aspidiotus*, and the other species, *O. furcillae*, was transferred by Balachowsky (1958) to *Abgrallaspis*.

Borchsenius (1966) enumerated *O. subrubescens*, the type-species, *O. araucariae*, originally described in *Octaspidiotus, O. australiensis*, which he transferred from *Aspidiotus*, and *O. corticoides*, originally described as a variety, and later treated by MacGillivray (1921) as a subspecies, of the type-species. *O. araucariae* is not congeneric with *O. subrubescens*. *O. australiensis* is referable to *Metaspidiotus*, if this is distinct.

Matile-Ferrero and Balachowsky (1973) described *O. caledonicus*. This species seems to be close to *Aspidiotus spinosus* and somewhat related to *O. araucariae*, and all these species should be removed to another genus, which will be described as new hereinafter.

At least 7 species originally described in *Aspidiotus* apparently form a group, *Metaspidiotus*. These species are different from the type-species of *Octaspidiotus* in lacking the 4th pair of pygidial lobes and in the plates occurring outside the 3rd lobes all with considerably fleshy processes, but in other respects very similar to the latter. Above all, the *Metaspidiotus* species and *Octaspidiotus subrubescens* agree in having lanceolate setae on the bases of the 2nd and 3rd lobes, a character which has been overlooked by most authors who studied these species. This type of setae is quite unusual in the Diaspididae, so that the occurrence of lanceolate setae in constant association with other characters in all these species gives a strong reason for considering them to belong to a close phylogenetic·group. *Octaspidiotus* and *Metaspidiotus* should be united in one genus. In this concept the genus *Octaspidiotus* comprises at least the following 9 species:

O. subrubescens	Australia (Queensland)
O. calophylli n. comb.	Ceylon; India (Nilgiri)
O. stauntoniae n. comb.	Japan; Korea; Taiwan; Continental China; Hainan; Philippines
O. tripurensis n. sp.	India (Tripura); Thailand
O. tamarindi n. comb.	India (Coimbatore)
O. nothopanacis n. comb.	Continental China (Yunnan)
O. machili n. comb.	Taiwan
O. multipori n. comb.	Japan
O. australiensis	Australia; Solomon Is.; New Guinea; Philippines; India (Uttar Pradesh); Nepal

Recognition characters (adult female). Aspidiotines with prepygidial region of body rounded and with pygidium more or less produced. Derm remaining membraneous in prepygidial region or, in some species, thickly sclerotized throughout at maturity. Pygidial lobes in 3 or 4 pairs, parallel or slightly divergent. Median lobes well developed, notched subapically on lateral side and usually also on the mesal; each of median lobes basally well demarcated by a narrow membraneous zone, thus appearing as if jointed, and on ventral side with a conspicuous sclerotization extending into pygidium. Second lobes smaller than the median, notched subapically on lateral side and often also on the mesal. Third lobes as large as the

2nd, usually distinctly notched only on lateral side. Fourth lobes, when present, much smaller, pointed apically, and notched on lateral side. Marginal setae occurring on dorsal bases of 2nd and 3rd lobes lanceolate, being broadened and flattened; dorsal marginal seta occurring on 4th lobe or, when this is replaced by a plate, on 5th abdominal segment also often more or less lanceolate. Plates as long as or a little longer than adjacent lobes, 2 between median lobes and also between the median and 2nd, 3 between 2nd and 3rd lobes and also between the 3rd and 4th when the last is present; more laterally plates occurring as far as marginal setae of 4th abdominal segment; plates occurring between lobes fringed, those occurring outside lateralmost lobe (3rd or 4th lobe) broad, dentate, more or less sclerotized especially on the dentate margin, at mesal angle with 1 or a few long processes, which are more or less fleshy and often furcate. No paraphyses on pygidial margin. Pygidium dorsally with 3 pairs of intersegmental furrows more or less clear towards apex; mesalmost of these furrows extending from between median and 2nd lobes anteriorly to level of anal opening, the 2nd occurring between 2nd and 3rd lobes and extending more anteriorly, and the lateralmost beginning laterad of 3rd lobe and extending for some distance parallel to pygidial margin. Dorsal macroducts mostly occurring in these furrows, forming 3 pairs of rows; elongate, but not filiform, with the orifice elliptical; in the species which grow sclerotized at maturity the dorsal macroducts also tend to be sclerotized at maturity for a short distance just within the orifice; 1 marginal macroduct between median lobes and also between the median and 2nd, 2 (or 1 in *O. australiensis*) between 2nd and 3rd lobes, 1 or more often 2 between 3rd lobe and seta indicating 5th abdominal segment (or 4th lobe in *O.subrubescens*), and a few beyond. Anal opening more or less elongate, situated at about posterior 3rd of pygidium. Vulvar opening situated well anterior to anal opening. Perivulvar disc pores present in antero- and posterolateral groups, the median group absent or sometimes represented by a few disc pores often set close to anterior end of one of anterolateral groups. A slender ventral sclerotization occurring in front of 2nd lobe and extending anteriorly to level of anal opening, usually with a seta at its anterior end. Short lateral macroducts arranged along body margin on 1st to 3rd abdominal segments and sometimes also in posterolateral corner of metathorax.

Remarks. This genus is characterized by that the dorsal marginal setae occurring on the 2nd and 3rd lobes are peculiarly modified in shape. These setae are broadened, flattened dorsoventrally, and more or less translucent, and may be called lanceolate setae (so far as observed, the corresponding setae in the 2nd instar male and female are also more or less lanceolate). They are apparently different from such simply thickened setae as found in *Unaspidiotus*, *Acanthaspidiotus*, and *Oceanaspidiotus* (n. gen.).

In some characters this genus is similar to *Aspidiotus*. Besides having lanceolate setae, it differs from the latter in the median lobes appearing as if jointed, in the plates occurring outside the lateralmost lobes dentate, sclerotized in the dentate margin, and produced at the mesal side into fleshy processes, and in the rows of dorsal macroducts extending comparatively well anteriorly. In the last character *Octaspidiotus* is more similar to *Selenomphalus, Hypaspidiotus, Crassaspidiotus*, etc. than to *Aspidiotus*. However, it agrees not with *Selenomphalus* and others, but again with *Aspidiotus*, in having clear furrows where the macroducts are arranged. Most species of *Octaspidiotus* have paired marginal macroducts between the 2nd and

3rd lobes, agreeing in this respect with the species of *Aspidiotus* and *Crassaspidiotus*. *Selenomphalus* and *Hypaspidiotus* differ from all of them in having a single marginal macroduct in that position.

On the other hand, this genus is similar to *Selenomphalus* and *Hypaspidiotus* in the state of the plates occurring outside the lateralmost lobes. In *Crassaspidiotus* these plates are fringed rather than dentate, but with the processes all rather fleshy than filiform, thus showing an intermediate state between the filiformly fringed plates of *Aspidiotus* and the dentate plates of *Octaspidiotus*. *Crassaspidiotus* and *Hypaspidiotus* agree in the 3 pairs of lobes all of the same size and not notched. *Selenomphalus* also agrees with them in the mesal 2 pairs of lobes subequal in size, but differs in these lobes notched as in *Octaspidiotus* and many species of *Aspidiotus*. Among all these genera *Selenomphalus* is peculiarly characterized by the 3rd lobes modified into strongly sclerotized spurs, in this repect agreeing with *Selenaspidus* and others.

Our knowledge of the aspidiotine scale insects is still too meagre to evaluate such crossing combinations of characters as found in *Octaspidiotus* and its supposed relatives. All these genera overlap in geographical distribution and may be more or less related phylogenetically.

Octaspidiotus subrubescens [Figs. 4, 13]

Aspidiotus subrubescens Maskell, 1892, Transactions of New Zealand Institute 24 : 9 ["In Australia, on *Eucalyptus*"].

Octaspidiotus subrubescens : MacGillivray, 1921, The Coccidae, p. 395.

Octaspidiotus subrubescens : Ferris, 1937, Microentomology 2 : 87 (fig. 66)[illustrated].

Material. About 20 adult females from Queensland, Australia (Imbil ; Coolangatta ; Stanthorpe ; Yarraman ; etc.), collected on *Caelebogyne ilicifolia, Capparis mitchelli, Citrus australis, Eucalyptus, Flindersia bennettiana, Nerium oleander, Owenia venosa*, and *Pinus caribaea* [in the collection of the Entomology Branch, Department of Primary Industries, Brisbane, Australia].

Recognition characters (adult female). Pygidium with 4 pairs of lobes. Median lobes parallel, separated from each other by a space about half as wide as one of them. The mesalmost of the plates occurring between the 2nd and 3rd lobes is only a little reduced in size in comparison with the outer two. There are between the 3rd and 4th lobes 3 plates, which are broader than the other interlobar plates but elaborately fringed as well. Four or 5 broad plates occurring outside 4th lobe, with long processes only a little fleshy. Lanceolate setae occurring on 2nd and 3rd lobes shorter than these lobes. Dorsal macroducts and perivulvar disc pores, see Table 1. Lateral macroducts on basal 3 abdominal segments, about 16–32 in total on one side of body.

Remarks. Mr. S. Nakahara, having examined Maskell's material of this species, informed me as follows : "Maskell's material of *subrubescens* has shorter lobes than your illustration, and this is true also for material from *Eucalyptus*. Many of the lobes are somewhat truncate just apical to the lateral notch. However, material from *Pittosporum* has lobes more like your illustration. Apparently, the dorsal seta at the base of lobe 4 in Maskell's and *Eucalyptus* material are regular marginal setae and not conical, although some setae appear to be conical. The second stage has a regular marginal seta at the base of lobe 4". The variation here in the shape of the

lobes may or may not be primary, for in aged individuals the lobes may have worn off to be truncated apically.

Green (1905) described "*Aspidiotus (Evaspidiotus) subrubescens*, Mask., var. *corticoides*" from Victoria, Australia, as occurring on *Eucalyptus globulus*. This variety was distinguished by the more opaque scale, proportionately broader pygidium, and the more numerous (17-27) anterolaterals of perivulvar disc pores. However, the supposed differences in the scale colour and pygidial shape may also be characteristic of fully aged individuals. The anterolateral perivulvar disc pores may be unusually numerous for *O. subrubescens*, but this cannot be adopted as a valid character until a statistical comparison has been made. On the other hand, his illustration shows plates unusually short for an *Octaspidiotus* species.

Octaspidiotus calophylli, new combination [Figs. 1, 9, 14]

Aspidiotus calophylli Green, 1922, Journal of the Bombay Natural History Society 28: 1008 ["On foliage of *Calophyllum walkeri*. Namunakuli Hill, Badulla", Ceylon].

Aspidiotus calophylli: Green, 1937, Ceylon Journal of Science, B. Zoology and Geology 20 (3): 330 ["Recorded also from India"].

Material. Sixty-three adult females mounted from material collected in Nilgiri, Tamil Nadu, India, Nov. 21-29, 1978: near Coonoor, 1810-1830 m, on a lauraceous plant (*Neolitsea* sp. ?) [78 IND-199; 31 adult females mounted] and *Maesa* sp. (?) [78 IND-207; 31 adult females mounted]; and near Kotagiri, 1740 m, on *Symplocos laurina* [78 IND-235; 1 adult female mounted]. Occurring on the leaves, on both surfaces. Scales of both sexes thin, grayish brown.

Recognition characters (adult female). At maturity body strongly sclerotized, with a slight lateral constriction demarcating thorax from abdomen; pygidium also demarcated by a distinct constriction between 2nd and 3rd abdominal segments, usually slightly concave on margin around setae of 4th abdominal segment; segmentation strongly defined dorsally between meso- and metathorax, and between metathorax and abdomen, pygidium likewise strongly defined from other part of body, thus a well-defined region is formed between the metathorax and pygidium; this region, supposed to be composed of the 1st and 2nd abdominal segments, is further divided into 4 transverse partitions except laterally; a submarginal dorsal boss present on abdomen in front of pygidium and also on basal segment; anothr boss anterolateral to anterior spiracle. Pygidial lobes in 3 pairs; median lobes nearly parallel or slightly divergent, separated from each other by a space a little wider than half width of one of them. Lanceolate setae on 2nd and 3rd lobes shorter than these lobes. Three plates occurring between 2nd and 3rd lobes all equally developed. Outside 3rd lobe 7-10 plates well developed, with fleshy processes. Numbers of dorsal macroducts and perivulvar disc pores, see Table 1. Lateral macroducts occurring on basal 3 abdominal segments and usually also in posterolateral corner of metathorax, about 20-47 in total on one side of body.

Remarks. Ramakrishna Ayyar (1930) recorded "*Aspidiotus calophylli* var. *symplocos*, Green (MS)" from Coonoor, Nilgiri, as occurring on *Symplocos* leaves. According to him this form is characterized by the scale "really white, though covered with earthly deposit." The material at hand, also collected in Nilgiri on *Symplocos* and other plants, may fall into this form, but disagrees with his statement in the scale colour.

No material from Ceylon has been available for comparison. Green's description of *Aspidiotus calophylli* is rather short, and disagrees with the present material in the perivulvar disc pores slightly more numerous ("upper groups with from 15 to 23, lower groups with from 14 to 18 pores") and in the body larger ("2 mm" !). But his illustration, showing a characteristic body shape, well agrees with the present material.

This species is undoubtedly closely related to *O. stauntoniae* and *O. tripurensis* (n. sp.), but is distinguishable by the numbers of the dorsal macroducts and perivulvar disc pores (see under *O. stauntoniae* and *O. tripurensis*). In a few specimens, seemingly fully matured, some dorsal macroducts occurring internally are sclerotized just within the orifice for a short distance as in *O. stautoniae* and *O. tripurensis*, but not so strongly as in the latter two.

Octaspidiotus stauntoniae, new combination [Figs. 1, 10, 15]

Aspidiotus stauntoniae Takahashi, 1933, Department of Agriculture, Government Research Institute, Formosa, Report 60 : 54 [Taiwan, on *Stauntonia obovatifoliola*].

Aspidiotus stauntoniae : Takahashi and Tachikawa, 1956, Transactions of Shikoku Entomological Society 5 : 14 [Japan, on *Aucuba japonica, Elaeagnus pungens, Hedera rhombea*, and *Fatsia japonica*].

Metaspidiotus stauntoniae : Takagi, 1957, Insecta Matsumurana 21 : 36 [redescribed ; Japan, on *Hedera rhombea*].

Metaspidiotus stauntoniae : Takagi, 1969, Insecta Matsumurana 32 : 91 [redescribed ; Taiwan, on *Hibiscus tiliaceus*].

Metaspidiotus stauntoniae : Paik, 1978, Illustrated Flora & Fauna of Korea 22, Insecta (VI) : 365 [Korea, on *Hedera tobleri*].

Material. A large number of adult females mounted from material collected in Honsyû (Bôsô Peninsula ; Tôkyô ; Hakone ; Kii Peninsula ; Hyôgo-ken, etc.) and Sikoku (Matuyama ; Ùwazima ; Kôti), Japan, on *Aucuba japonica, Dendropanax trifidus, Fatsia japonica, Hedera rhombea, Elaeagnus pungens*, etc. Further material from Japan : Kyûsyû (Hukuoka ; Kagosima ; etc.), on *Aucuba japonica* and *Skimmia japonica* ; Tusima (islands between Kyûsyû and Korea), on *Lindera obtusiloba* ; Amami-Ôsima and Tokuno-Sima, Ryûkyû Is., on garden citrus and an undetermined plant. Taiwan (Hengchun), on *Hibiscus tiliaceus*. Continent of China (Foochoo ; Shanghai), on *Aleurites cordata, Ficus retusa*, oleander, etc. Hainan, on *Litsea cubea*. Philippines, on *Chrysomphyllum cainito, Arundina bambusifolia, Mangifera indica, Psidium guajava*, etc., mainly collected at plant quarantine, Honolulu. [The specimens from Foochoo, Shanghai, Hainan, and the Philippines : in the collection of the U.S. National Museum.] Occurring on the leaves of the host plants ; found also on the green twigs of citrus. Scales of both sexes thin, grayish brown.

Recognition characters (adult female). Very similar to *O. calophylli* and *O. tripurensis* (n. sp.), but distinguishable from *O. calophylli* by having much fewer dorsal macroducts and perivulvar disc pores and from *O. tripurensis* by having much fewer perivulvar disc pores (Table 1 ; Fig. 1). Pygidium appearing less acute than in *O. calophylli*, straight on margin anterior to plate series. At maturity derm strongly sclerotized, and dorsal and lateral macroducts also strongly sclerotized just within the orifice for a short distance. Lateral macroducts on basal 3 abdominal segments, about 13-40 in total on one side of body.

Remarks. In Japan this species is associated with *Aucuba japonica* and a

limited number of other plants mainly of the family Araliaceae, while in southern countries it has been found on a wide range of plants. Morphologically there is no difference between the Japanese and southern forms except for the number of the perivulvar disc pores, in which, however, all the examined specimens form a continuous series of variation (Fig. 1).

Octaspidiotus tripurensis, new species [Figs. 1, 10, 16]

Material. Nine adult females (one the holotype) collected at Agartala, Tripura, India, on *Thevetia peruviana* leaves, Feb. and July 1982, by B. K. Agarwala [holotype and 4 paratypes in the collection of the Department of Zoology, University of Calcutta; 4 paratypes in the collection of the Entomological Institute, Hokkaidô University]. One adult female, Thailand, on *Ficus religiosa* [in the collection of the U.S. National Museum].

Recognition characters (adult female). Very similar to *O. calophylli* and *O. stauntoniae*, but distinguishable from *O. calophylli* by having fewer dorsal macroducts and from *O. stauntoniae* by having much more numerous perivulvar disc pores (Table 1; Fig. 1). At maturity derm strongly sclerotized, and most dorsal macroducts also strongly sclerotized within the orifice for a short distance. Pygidium straight or slightly convex on margin anterior to plate series. Mesalmost of plates occurring between 2nd and 3rd lobes tending to be reduced in comparison with the outer two. Lateral macroducts on basal 3 abdominal segments, 12-22 in total on one side of body.

Remarks. This species differs from *O. calophylli* in having fewer dorsal macroducts. Though these species slightly overlap in the total number of these macroducts, they appear to form different groups when plotted on a scatter diagram drawn for the numbers of the macroducts and perivulvar disc pores (Fig. 1). In the shape of the pygidium *O. tripurensis* is similar to *O. stauntoniae* rather than to *O. calophylli*. The fact that the perivulvar disc pores are much more numerous in *O. tripurensis* is almost the only positive reason to recognize it as distinct from *O. stauntoniae*. The difference is, nevertheless, great. This difference is more remarkable and significant when the geographical variation of *O. stauntoniae* is taken into consideration. In *O. stauntoniae* the perivulvar disc pores have an obvious tendency to decrease at lower latitudes (Fig. 1). This is well shown by simply comparing the material from Japan with that from southern Asia (Table 2). This geographical pattern of variation rules out the possibility that *O. tripurensis* is merely an extreme form within the supposed clinal variation of *O. stauntoniae*, because *O. tripurensis* comes from latitudes as low as for the southern form of *O. stauntoniae*.

Octaspidiotus tamarindi, new combination [Fig. 10]

Aspidiotus tamarindi Green, 1919, Records of the Indian Museum 16 (7): 439 [Coimbatore, India, on *Tamarindus*].

Aspidiotus tamarindi: Ferris, 1941. Microentomology 6 (2): 59 [redescribed on the basis of a single mounted specimen from the type lot].

Material. Eight mounted adult females collected at Coimbatore, Tamil Nadu, India, on *Tamarindus indica*, Dec. 1, 1978 [78 IND-262], all in very poor condition, probably having been collected at some time after their death. Occurring on the

leaves.

Recognition characters (adult female). Body remaining membraneous except for apical region of pygidium. Lobes and lanceolate setae nearly as in *O. calophylli*, *O. stauntoniae*, and *O. tripurensis*. Mesalmost of plates occurring between 2nd and 3rd lobes apparently narrower than the lateral two ; 7 or 8 plates occurring outside 3rd lobe, all well developed, with fleshy processes. Dorsal macroducts fewer than in *O. stauntoniae*, but perivulvar disc pores comparatively numerous (Table 1). Lateral macroducts on basal 3 abdominal segments, about 23-28 in total on one side of body.

Remarks. The material at hand was collected at the type-locality and on the type-host, so that there may be little doubt that it belongs to this species. At first glance this species appears quite different from *O. calophylli*, *O. stauntoniae*, and *O. tripurensis*, because, at maturity, it remains membraneous, while the latter three are strongly sclerotized, manifesting remarkable characters in association with the sclerotization. But all the 4 species are very similar in the characters of the pygidial margin except for the mesalmost plate between the 2nd and 3rd lobes narrowed in *O. tamarindi* and tending to be so in *O. tripurensis*. They differ from each other in either or both of the numbers of the dorsal macroducts and perivulvar disc pores, occupying their own positions when these numbers are plotted on a scatter diagram. So far as based on the specimens at hand *O. tamarindi* has a quite broad pygidium, but this may partly be due to the fact that they were collected after oviposition.

Octaspidiotus nothopanacis, new combination [Fig. 5]

Aspidiotus nothopanacis Ferris, 1953, Microentomology 18 (3): 66 [Sishan, near Kunming, Yunnan Province, China, on *Nothopanax delavayi* ; "In many respects it resembles the type of the genus *Octaspidiotus*, but it does not possess the distinct fourth lobe of this speies."].

Material. Three adult females, one of them labelled "UCD type # 498", Sishan, near Kunming, Yunnan Province, China, on *Nothopanax delavayi* [No. 813], and 7 adult females, same locality, on *Ternstroemia* sp. [No. 806] [in the collection of the University of California, Davis].

Recognition characters (adult female). Body remaining membraneous except for apical region of pygidium. Pygidium well produced, with 3 pairs of lobes. Median lobes separated from each other by a space a little narrower than one of them. Lanceolate setae shorter than 2nd and 3rd lobes. Three plates occurring between 2nd and 3rd lobes all well developed ; 7 or 8 plates occurring outside 3rd lobe, the outer three or four with fleshy processes very short or obsolete, and the outermost one or two more or less rudimentary. Numbers of dorsal macroducts and perivulvar disc pores, see Table 1. Lateral macroducts on basal 3 abdominal segments, 14-21 in total on one side of body.

Remarks. Ferris described this species in detail ; nevertheless he overlooked the occurrence of the lanceolate setae. Further, he described about "very small and indistinct paraphyses arising from each basal angle" of the 2nd lobe, but these appear to be mere sclerotized folds flanking the marginal macroducts.

In 1 specimen from the lot No. 806 the 3rd lobes on both sides are replaced by plates, but the associated dorsal setae are lanceolate. In another specimen, from the same lot, the 3rd lobe of one side is deformed to an intermediate state between

the lobe and plate. In the limits of the present material it is not possible to know whether this is accidental or suggests a constant tendency of the species towards the loss of the 3rd lobes.

Octaspidiotus machili, new combination [Fig. 10]

Aspidiotus machili Takahashi, 1931, Journal of the Society of Tropical Agriculture, Taihoku Imperial University 3 (4): 384 [Taiwan, on *Machilus* sp.].

Metaspidiotus machili: Takagi, 1969, Insecta Matsumurana 32: 92 [redescribed; Taiwan, on *Schefflera octophylla*].

Material. Fifteen mounted adult females collected in southeastern Tai-pei Hsien, Taiwan, on *Schefflera octophylla* leaves. Female scale translucent, pale straw-coloured, and convex dorsally.

Recognition characters (adult female). Body remaining membraneous except for pygidium. Median lobes squat, about as long as wide, separated from each other by a space as wide as or wider than half width of one of them. Lanceolate setae attaining, or, more often, extending beyond, the apices of 2nd and 3rd lobes. Three plates occurring between 2nd and 3rd lobes all well developed; 8 or 9 plates occurring outside 3rd lobe, all well developed, with fleshy processes. Numbers of dorsal macroducts and perivulvar disc pores, see Table 1. Lateral macroducts occurring on basal 3 abdominal segments and sometimes also in posterolateral corner of metathorax, 22-41 in total on one side of body.

Remarks. The known host plants of this species belong to the family Lauraceae. In the characters of the pygidial margin this species is very similar to the Japanese *O. multipori* (see under *O. multipori*).

Octaspidiotus multipori, new combination [Figs. 10, 13]

Aspidiotus multipori Takahashi, 1956, Insecta Matsumurana 20: 24 [Japan, on *Illicium anisatum*].

Metaspidiotus multipori: Takagi, 1956, Insecta Matsumurana 21: 37.

Material. Honsyû (Mie-ken; Wakayama-ken; Yamaguti-ken) and Kyûsyû (Hukuoka-ken; Nagasaki-ken; Kagosima-ken), Japan, on *Illicium anisatum* (=*I. religiosum*) and *Skimmia japonica*. Mounted specimens examined include the type (Mozi, Yamaguti-ken, on *Illicium anisatum*) and many specimens collected at Yunoyama-Onsen, Mie-ken, on *Illicium anisatum* and at Makizono, Kagosima-ken, on *Skimmia japonica*. Occurring on the leaves. Scale of female thin, grayish brown.

Recognition characters (adult female). Body remaining membraneous except for pygidium. Pygidial lobes very similar to those of *O. machili*. Lanceolate setae translucent, extending beyond apices of 2nd and 3rd lobes. Ventral marginal seta occurring at outer basal corner of 2nd lobe tending to be thickened. Three plates occurring between 2nd and 3rd lobes all well developed; 5-10 (usually 7 or 8) plates occurring outside 3rd lobe, all well developed. Dorsal macroducts of pygidium numerous (Table 1); 1 macroduct (or rarely 2) often present just in front of marginal macroduct occurring between bases of median lobes. Lateral macroducts on basal 3 abdominal segments, sometimes 1 or 2 further macroducts in posterolateral corner of metathorax, total 16-38 on one side of body. Perivulvar disc pores few in comparison with dorsal macroducts (Table 1). Numerous ventral microducts scat-

tered submarginally and submedially in prepygidial region.

Remarks. This species is very similar to *O. machili* in the characters of the pygidial margin, but is quite distinct from the latter, having much more numerous dorsal macroducts and more numerous perivulvar disc pores. The prepygidial microducts are also more numerous, but the lateral macroducts are not, in *O. multipori*.

Octaspidiotus australiensis [Figs. 2, 11, 12, 17]

Aspidiotus australiensis Kuwana, 1931, in Kuwana and Muramatsu, Dobutsugaku Zasshi (Zoological Magazine, Japan) 43 : 652 [on an orchid imported from Thursday Is., Australia].

Octaspidiotus australiensis : Borchsenius, 1966, A Catalogue of the Armoured Scale Insects (Diaspidoidea) of the World, p. 272.

Material. Twelve adult females collected on orchids (*Dendrobium toftii, D. sanderae, Vanda* sp., etc.) imported at Los Angeles or Honolulu from Australia, Solomon Is., New Guinea, and the Philippines [in the collection of the U. S. National Museum]. Twenty-one adult females mounted from material collected at Sahastradhara, 870 m, Uttar Pradesh, India, on *Cocculus laurifolius* leaves [78IND-118] and branches [78IND-122], Nov. 6, 1978. Many specimens collected in Central Nepal : Godavari, ca. 1600 m, near Kathmandu, on *Symplocos crataegoides* leaves and branches, Aug. 18, 1975 [75NPL-22] ; Sheopuri, ca. 1700 m, near Kathmandu, on *Eurya* sp. branches, Sept. 1, 1975 [75NPL-130] ; Ramche, ca. 1750 m, Bagmati, on *Maesa chisia* branches, Sept. 13, 1975 [75NPL-183]. Also collected at Ramche, 1500 m, Bagmati, Nepal, on *Maesa macrophylla* branches, Sept. 15, 1975 [75NPL-194], but the mounted specimens are all in poor condition. Scales of both sexes thin, dirty brown (male scales found in 78IND-118).

Recognition characters (adult female). Body remaining membraneous except for pygidium. Pygidium with 3 pairs of lobes. Median lobes appressed together, with a narrow space between ; each lobe asymmetrical, with lateral margin sloping and deeply incised, the notch on mesal side placed more apically or disappearing. Second and 3rd lobes, when notched, only so on lateral side. Lanceolate setae well developed, extending more or less beyond apices of associated lobes ; ventral marginal seta occurring at lateral basal angle of 2nd lobe also strong. Two plates between median lobes slender, spiniform or slightly fringed ; mesalmost of 3 plates occurring between 2nd and 3rd lobes modified into a narrow and simple process ; 6-10 (usually 7 or 8) plates outside 3rd lobe, all well developed, with fleshy processes. Numbers of dorsal macroducts and perivulvar disc pores, see Table 1. Lateral macroducts occurring on basal 3 abdominal segments and sometimes also in posterolateral corner of metathorax, about 8-29 in total on one side of body. Ventral microducts numerous in prepygidial region, scattered submarginally along body margin.

Remarks. No specimen from the type-series has been available for comparison. (I looked through Kuwana's collection, which is deposited partly in the National Institute of Agricultural Sciences and partly in Yokohama Plant Protection Station, but could not find the type or type-series of *Aspidiotus australiensis*.) The specimens collected at quarantine on orchids and at Sahastradhara on the leaves of *Cocculus laurifolius* agree with Kuwana's description and illustration of *Aspidiotus australiensis* except for the state of the dorsal setae (lanceolate setae) occurring on

the 2nd and 3rd lobes and that of the mesalmost plate between these lobes. Since the lanceolate setae have also been overlooked in other species, there is little doubt that these specimens belong to the present species.

The specimens collected on the branches of the host plants in Nepal differ from the above-mentioned form in the pygidium much broader, the median lobes robuster and appressed together more closely, and the 2nd and 3rd lobes with the distal part, apical to the subapical notch, much shorter and, thus, more exceeded by the lanceolate setae.

These 2 forms themselves appear well discrete from each other (Fig. 11 and Fig. 12), but are connected by intermediate individuals. Material was also obtained at Sahastradhara from the branches of another *Cocculus laurifolius* tree (78IND-122). The specimens mounted from this lot are variable : some of them are rather similar to the 1st form, whereas others more or less approach to the 2nd form. One lot from Nepal (75NPL-22) contains leaf-feeding individuals, too, which are generally similar to the branch-feeding individuals of the same lot. Some of them are, however, more or less similar to the 1st form in the characters of the pygidial lobes. The pygidium is comparatively broad in such individuals, but this may at least partly be due to the fact that they are matured females, having eggs within the body.

All the specimens here are, therefore, regarded as belonging to the same species, representing another example of the dimorphic variation associated with feeding sites, now well known in some diaspidids. The dimorphic variation is not completely manifested in the lot 78IND-122 and the leaf-associated individuals of the lot 75NPL-22 for an unknown reason.

The examined specimens are also variable in the numbers of the dorsal macroducts and perivulvar disc pores. There is a significant difference in these numbers between the leaf- and branch-associated individuals from the lot 75NPL-22 (Fig. 2, F and G). However, there seem to be differences according to localities and/or host plants,too, and the whole variation may reflect the combined effect of all these factors. Anyhow, all the examined specimens form a continuous series in the numbers of these secretory organs and their correlation (Fig. 2).

The records of this species from orchids are all based on material collected at quarantine. Undoubtedly this species has frequently been transported together with orchids, so that I have some doubt as to whether it is really native to Australia, the Solomon Islands, New Guinea, and the Philippines, where it was exported in association with orchids. On the other hand, this species is very probably native to the Himalayas, where it was collected on wild plants.

KEY TO INCLUDED SPECIES (ADULT FEMALES)

Aspidiotines with broadened and flattened setae (lanceolate setae) on dorsal bases of 2nd and 3rd lobes ; plates occurring outside lateralmost lobe (3rd or 4th lobe) broad, dentate on margin, at mesal side with 1 or a few long processes, which are more or less fleshy ; median lobes basally demarcated by a narrow membraneous zone ; pygidium towards apex with 3 pairs of clear furrows, in which most of the dorsal macroducts are arranged, forming irregular rows, the mesalmost pair of rows extending anteriorly to level of anal opening, which is situated at about the posterior 3rd of the pygidium.

1. Fourth lobe present in a small, pointed, sclerotized process. ..... *O. subrubescens*.

— Fourth lobe replaced by a plate. ..... 2.
2. Lanceolate setae not extending beyond apices of 2nd and 3rd lobes (except in teneral individuals). ..... 3.
— Lanceolate setae more or less extending beyond apices of 2nd and 3rd lobes. ..... 7.
3. Body strongly sclerotized at maturity; plates occurring outside 3rd lobe all with long processes well developed; if the mesalmost of the plates occurring between the 2nd and 3rd lobes is apparently narrower than the lateral two, the perivulvar disc pores are as numerous as some 40 or more. ..... 4.
— Body remaining membraneous. ..... 6.
4. Perivulvar disc pores not so numerous as some 30. ..... *O. stauntoniae.*
— Perivulvar disc pores more numerous. ..... 5.
5. Dorsal macroducts of pygidium as numerous as some 70 or more; pygidium usually slightly concave on margin around setae of 4th abdominal segment; mesalmost plate between 2nd and 3rd lobes well developed. ..... *O. calophylli.*
— Dorsal macroducts of pygidium less numerous; pygidium straight or slightly convex on margin anterior to plate series; mesalmost plate between 2nd and 3rd lobes tending to be narrower than lateral two. ..... *O. tripurensis.*
6. Mesalmost plate between 2nd and 3rd lobes narrower than lateral two; plates occurring outside 3rd lobe all with fleshy processes well developed. ..... *O. tamarindi.*
— Plates occurring between 2nd and 3rd lobes all well developed; outermost three or four of plates occurring outside 3rd lobe with fleshy processes much reduced or obsolete. ..... *O. nothopanacis.*
7. Median lobes appressed together, with a slender space between. ..... *O. australiensis.*
— Median lobes separated from each other by a space at least half as wide as one of them. ..... 8.
8. Dorsal macroducts not so numerous as some 80. ..... *O. machili.*
— Dorsal macroducts as many as some 80 or more. ..... *O. multipori.*

RELATIONSHIP AMONG SPECIES

The species included in *Octaspidiotus* are generally uniform in the external characters of the adult females, so that only a limited number of characters are available for constructing morphoclines. Sometimes species distinctly differ almost exclusively in the numbers of the dorsal macroducts and perivulvar disc pores, but it is difficult to determine polarity for morphoclines constructed for these numbers (unless other morphoclines concordant with them are available). Age factor must also be taken into consideration. In some species the pygidium is acute, appearing strongly produced, while in others quite broad, appearing much less produced. But the shape of the pygidium is also variable according to age, so that it may be better excluded from the discussion here.

In *O. calophylli, O. stauntoniae,* and *O. tripurensis* the external derm of the body is strongly sclerotized at maturity. This sclerotization must be secondary and, therefore, a derived character (morphocline I). (However, there is no ground to believe that reverse changes have not occurred in the genus.)

O. stauntoniae is characterized by the dorsal and lateral macroducts strongly sclerotized for a short distance just within the orifice at maturity. In *O. tripurensis* most of the dorsal macroducts are sclerotized likewise, and in *O. calophylli*, so far as observed, at most only part of the dorsal macroducts are sclerotized and not so strongly as in the former two. This type of sclerotization of macroducts is quite unusual not only in the Aspidiotini but also in the whole Diaspididae, so that it is considered to be an undisputable derived character and to suggest a close phylogen-

etic relationship among the 3 species (morphocline II). (But the possibility cannot wholly be ruled out that there is in the species of the genus a common tendency of the macroducts to be sclerotized within the orifice in association with the sclerotization of the external derm, for there is known in this genus no species in which the external derm is, at maturity, strongly sclerotized and yet the macroducts show no trace of sclerotization.)

The arrangement of the dorsal macroducts is uniform in the genus except for slight modifications in 2 species. In *O. multipori* 1 or 2 additional macroducts are often found in front of the marginal macroduct placed between the bases of the median lobes. This is apparently associated with the occurrence of unusually numerous macroducts on the pygidium. The number of macroducts itself is not adopted for comparison for the reason stated above, though the occurrence of unusually numerous as well as unusually few macroducts may be a derived rather than primitive character. On this supposition the occurrence of the additional submarginal macroducts is taken as a derived character (morphocline III). *O. australiensis* differs from the other species in having only 1 marginal macroduct, instead of 2, between the 2nd and 3rd lobes. Both types are found in other aspidiotines supposed to be related to *Octaspidiotus*, so that it is not possible to determine the polarity on the basis of a simple out-group comparison. However, the state in *O. australiensis* may be taken as a derived character on the supposition that it is due to the loss of one of the paired macroducts (morphocline IV).

The pygidial lobes are in 4 pairs in *O. subrubescens* and in 3 pairs in the other species. The 4th pair of lobes is found in a relatively small number of species scattered in the Diaspididae, and its occurrence may be reasonably interpreted as a relic character on the supposition that the decrease rather than increase of the number of lobes has been a general trend in association with the advance of pygidial reorganization (morphocline V).

The median lobes are well separated from each other except in *O. australiensis*, in which they are appressed together with a slender space left between them. The latter state is associated with a reduction of the space between the median lobes, which is supposed to belong to the 9th abdominal segment, so that it is interpreted as derived (morphocline VI). These lobes are generally very similar in shape among the *Octaspidiotus* species except for the appressed lobes in *O. australiensis*. In *O. machili* and *O. multipori*, however, the median lobes are obviously shortened. There is no positive reason for interpreting this state as derived or primitive.

The plates are well differentiated into the fringed type occurring between the lobes and the dentate type, with fleshy long processes, occurring outside the 3rd lobe except in *O. subrubescens*. The state in this species can be interpreted as incompletely differentiated on the basis of the fact that the plates occurring between the 3rd and 4th lobes are still fringed and those occurring outside the 4th lobe are dentate but with the long processes not so fleshy as in the other species. *O. subrubescens* should be primitive in this respect (morphocline VII). In *O. nothopanacis* anteriormost plates are more or less rudimentary. This character is undoubtedly secondary, and should be derived (morphocline VIII).

In *O. subrubescens* and some other species the plates occurring between the 2nd and 3rd lobes are all well developed and fringed. In *O. tamarindi* the mesalmost of these plates is obviously narrower and less fringed than the lateral two, and this is

also the case with *O. tripurensis* to some degree. The corresponding plate in *O. australiensis* is a simple, attenuating process, utterly differing in shape from the lateral two. This heteromorphism, most advanced in *O. australiensis*, should be a derived character (morphocline IX).

The lanceolate setae, unique to this genus, should be derived and specialized in comparison with the usual type. They are variable in size relative to the lobes both specifically and, to some extent, individually, and may be roughly divided into 2 classes: setae as long as or, more usually, shorter than the 2nd and 3rd lobes, and those extending beyond the apices of the lobes. This division may not wholly be valid, for the 2nd and 3rd lobes are also variable in length. But, if the lanceolate setae have any function, in scale formation for example, their relative size to the lobes may have some significance. It may be plausible to assume the relatively long lanceolate setae to be derived in comparison with the short ones (morphocline X).

In Table 3 the sequence of species is given for each of the morphoclines discussed above. These morphoclines are mostly composed of antipodal characters with no intervenients, so that the sequence of species is also short, contrasting 1 or a few species with all the others. Concordance in the sequence is also limited to a few pairs of morphoclines. The pattern here suggests, as a whole, a scattered rather than any particular (for example, ancestral-descendant) relationship among the species.

However, *O. subrubescens* appears singly at the primitive extreme in 2 morphoclines, and in no morphocline at the derived extreme. This species may represent a stage primitive, if not necessarily a form ancestral, to all the other species concerning the characters under consideration. On the other hand, *O. australiensis* appears at the derived extreme most frequently and, though still holding some primitive characters, is the most derived form as a whole.

O. calophylli, O. stauntoniae, O. tripurensis, and *O. tamarindi* are probably closely related phylogenetically as stated under the description. However, when plotted on a scatter diagram, they do not appear so close to each other in the correlation between the numbers of the pygidial macroducts and perivulvar disc pores. *O. machili* and *O. multipori*, being hardly distinguishable by the characters of the pygidial margin, may be close relatives, but they also differ too much in the numbers of these secretory organs to find an obvious connection between them.

OCEANASPIDIOTUS, NEW GENUS

Type-species. *Octaspidiotus araucariae*.

Composition. Two species originally described in *Octaspidiotus, O. araucariae* and *O. caledonicus*, should be excluded from that genus. They seem to be somewhat related to each other, and *O. caledonicus* is similar in many characters to *Aspidiotus spinosus*, which is a variable species and may include *Acanthaspidiotus borchsenii* as an extreme form of its variation. These species are tentatively lumped together under the new genus. Further, "*Aspidiotus* sp." recorded by Takagi (1975) from Nepal seems also to be related to them, but is excluded from this revision owing to the scanty material at hand.

Recognition characters (adult female). Aspidiotines with prepygidial region of body rounded and with pygidium broad. Derm remaining membraneous except for

pygidium. Pygidial lobes in 3 or 4 pairs (in *O. spinosus* there are 3 pairs of lobes, but the 3rd lobes are often membraneous and deformed). Median lobes well developed, set close, each basally with or without a prominent sclerotization extending into pygidium; lateral lobes variable in shape and size, but 4th lobes, if present, small and pointed. Plates well developed; 2 between median lobes, narrow, fringed or simple; other plates elaborately fringed or, outside the lateralmost lobe, tending to be modified into fleshy spiniform processes. Marginal setae occurring on dorsal bases of 2nd and 3rd lobes more or less thickened, widest basally or subbasally, gradually tapering towards apex. Pygidium dorsally with 3 pairs of clear furrows towards apex, with macroducts mostly arranged in these furrows, the mesalmost row of macroducts quite short, beginning between median and 2nd lobes. Dorsal macroducts slender, but not filiform, with orifice surrounded by a sclerotized rim. Shorter macroducts on 1st-3rd (or 2nd and 3rd) abdominal segments, arranged along margin. Anal opening subapical (in the type-species and *O. spinosus*) or situated more anteriorly (in *O. caledonicus*). Perivulvar disc pores present or absent.

Remarks. The 3 species referred to *Oceanaspidiotus* differ in the number of lobes, position of the anal opening, and the presence or absence of perivulvar disc pores, but otherwise they agree or at least are similar in tendency. The lateral lobes are more or less variable in size and shape in each of these species, and this variability may be adopted as one of the characteristics of the genus.

The dorsal marginal setae occurring on the 2nd and often also 3rd lobes are more or less thickened, but not similar to the lanceolate setae of the *Octaspidiotus* species. The plates occurring laterally to the lateralmost lobe are various in shape but not broadened to form dentate, sclerotized processes. The dorsal macroducts of the pygidium are slenderer and shorter than in *Octaspidiotus*. The thickened setae, the fleshy plates, and the slender dorsal macroducts also exclude the 3 species from *Aspidiotus*.

Some marginal setae are prominently thickened and the dorsal macroducts are small in *Acanthaspidiotus pustulans* (type-species of *Acanthaspidiotus*), too, but in this species the plates are all "obscurely furcate" or "spiniform" (Green, 1905) and the mesalmost row of dorsal macroducts, arising between the median and 2nd lobes and containing many ducts, extends much more anteriorly. The 3 species may tentatively be referred to *Acanthaspidiotus*, but, then, this genus appears to be too heterogeneous.

Oceanaspidiotus araucariae, new combination [Fig. 6]

Octaspidiotus araucariae Adachi and Fullaway, 1953, Proceedings of the Hawaiian Entomological Society 15 (1952): 89 [Oahu, on *Araucaria excelsa*].

Octaspidiotus araucariae: Nakahara and Miller, 1981, Proceedings of the Entomological Society of Washington 83 (1): 35 [Puerto Rico].

Octaspidiotus araucariae: Nakahara, 1981, Proceedings of the Hawaiian Entomological Society 23 (3): 402 [Hawaii, Maui, Molokai, Oahu].

Material. Four adult females, Oahu, Hawaii, on *Araucaria excelsa*, collected and identified by J.W. Beardsley [in his collection].

Recognition characters (adult female). Pygidium with 4 pairs of lobes. Median lobes with a trace of subapical notch on each side, basally with no sclerotization. Second lobes variable in size and shape, 3rd and 4th lobes small and pointed.

Plates well developed, extending beyond lobes. Dorsal macroducts few (Table 1), no macroduct between bases of median lobes. Lateral macroducts on 2nd and 3rd abdominal segments, 5-10 in total on one side. Anal opening elliptical, removed from bases of median lobes by at most about twice its longitudinal length. Perivulvar disc pores absent.

Remarks. The host plant, *Araucaria excelsa*, is native to New Caledonia and Norfolk Island, so that this scale insect may have originally been exported at either of these islands.

Oceanaspidiotus caledonicus, new combination [Figs. 7, 18]

Octaspidiotus caledonicus Matile-Ferrero et Balachowsky, 1973, Cahiers du Pacifique 17 : 239 ["sur feuilles de *Erythrina fusca fustigiata* à Nouméa (Nouvelle-Calédonie)"].

Material. Seven adult females (type-series), Noumea, New Caledonia, on *Erythrina fusca* var. *fustigiata* [in the collection of the Muséum National d'Histoire Naturelle, Paris].

Recognition characters (adult female). Pygidium with 4 pairs of lobes. Median lobes with a distinct subapical notch on lateral side, basally with a distinct sclerotization extending into pygidium. Second lobes varying from a small conical process to a well-developed process dilated apically and almost as large as median lobe. Third and 4th lobes small and conical. Dorsal marginal seta on 2nd lobe obviously, and that on 3rd lobe to a minor degree, thickened, extending beyond apices of these lobes. Plates fleshy ; 2 between median lobes spiniform ; 2 between median and 2nd lobes fringed ; 3 between 2nd and 3rd lobes, the mesalmost spiniform or slightly fringed, the lateral two broader and usually fringed ; 3 between 3rd and 4th lobes irregularly fringed or spiniform ; no or, more often, 1-5 plates present outside 4th lobe, spiniform or poorly fringed, usually followed by 1-3 minute processes. Number of dorsal macroducts, Table 1 ; there is 1 marginal macroduct between the bases of the median lobes. Lateral macroducts on basal 3 abdominal segments. Anal opening somewhat posterior to centre of pygidium. Perivulvar disc pores absent.

Remarks. This species differs from the type-species and *O. spinosus* by the position of the anal opening, a character generally very important in generic classification. Nevertheless, its resemblance to *O. spinosus* is very close.

Oceanaspidiotus spinosus, new combination [Figs. 3, 8, 17]

Aspidiotus spinosus Comstock, 1883, Report of the Department of Entomology, Cornell University Experiment Station 2 : 70 ["infests the leaves and branches of camellias in the conservatory of the Department of Agriculture"].

"*Aspidistis*" *persearum* Cockerell, 1898, The Entomologist 31 : 240 [Hawaiian Islands, from *Persea*].

Aspidiotus spinosus : Newstead, 1900, A Monograph of the British Coccidae 1 : 114 [The Royal Gardens, Kew, on *Arenga saccharifera*].

Aspidiotus spinosus : Ferris, 1941, Microentomology 6 (2) : 58 [redescribed].

Aspidiotus spinosus : Balachowsky, 1956, Annales du Musée Royal du Congo Belge, Nouvelle Série in-4°, Sciences Zoologiques 3 : 78 [redescribed].

Acanthaspidiotus borchsenii Takagi and Kawai, 1966, Insecta Matsumurana 28 : 116 [Japan (Tôkyô ; Idu Peninsula ; Hatizyô Is.), on *Platanus orientalis, Ligustrum obtusifolium, Hydrangea macrophylla, H. involucrata,* and *Boehmeria tricuspis*]. New synonymy.

Material. When I was examining a Nepalese aspidiotine, which well agrees

with *Acanthaspidiotus borchsenii*, I became aware that this species, while remarkably different in the pygidial margin from what I (1958) determined as belonging to *Aspidiotus spinosus*, cannot be distinguished from the latter in other features. Because the variable nature of the pygidial lobes is now well known in some aspidiotines and diaspidines, I supposed that the forms which I once treated as *Aspidiotus spinosus* and *Acanthaspidiotus borchsenii* might represent variations of the same species. On this supposition some specimens determined by foreign coccidologists as belonging to *Aspidiotus spinosus*, including part of the type-series, were examined and compared with my material. The result is not decisive, but strongly suggests that the 2 supposed species are at least very closely related. The specimens examined are divided for convenience as follows:

A. Nine adult females from the type-series of *Aspidiotus spinosus*, collected on *Camellia* in U.S.A.

B. Twenty-two adult females collected in North and South America: New Orleans, La., on *Citrus* twig; Brownsville, Texas, on *Euonymus* stem; St Lucie, Fla., on avocado leaf; Florida, at N.Y., on avocado fruit; Mexico, at Nogales, on mango leaf; Puerto Rico, at Miamai, on pigeon pea stalk; Costa Rica, at Miami, on orchid leaf; Brazil, on bromeliaceous plant leaf.

C. Seven adult females which I (1958) determined as belonging to *Aspidiotus spinosus*. Ao-Sima, Miyazaki-ken, Japan, on *Smilax stenopetala* stem.

D. Ten adult females from the type-series of *Acanthaspidiotus borchsenii*. Hatizyô Is., Idu Islands, Japan, on *Hydrangea macrophylla*.

E. One adult female, Yaku-Sima, Kagosima-ken, Japan, on *Eurya emarginata*.

F. Fourteen adult females from Nepal. Between Betrawate and Ramche, 1370 m, Bagmati, on *Maesa macrophylla* branch, Sept. 13, 1975 [75 NPL-176]; Ramche, 1750 m, on *Maesa chisia* branch, Sept. 13, 1975 [75 NPL-183]; Ramche, 1500 m, on *Maesa macrophylla* branch, Sept. 15, 1975 [75 NPL-194].

G. One adult female, Antalya, Turkey, on *Viburnum*.

H. Seven adult females, Parc de Santa Cruz, Tenerife, Canary Is., on *Euphorbia regisjubae*.

Comparisons. Not only all the pairs of lobes but also the marginal setae occurring on the 5th to 7th abdominal segments are remarkably variable. Because these features vary together to some extent, they may be described in terms of varying forms. In the specimens from America (material A and B) a wide range of variation is observed even among individuals probably from the same breeding colonies, and the variation here has no relation with feeding sites. In an extreme form, the median lobes are moderately large, the 2nd lobes are well developed and expanded, with the apex attaining the same level with the median lobes, and the 3rd lobes are also well developed and only a little smaller than the 2nd; the marginal setae are thickened, especially on the 7th abdominal segment (that is, on the 2nd lobes), but not remarkably. This form may be called "*persearum*-form" according to Ferris (1941) (Fig. 8, B1). In the opposite extreme, the median lobes are prominent, the 2nd lobes are reduced to more or less tubercular processes, and the 3rd lobes are deformed to conical or plate-like processes; the marginal setae are enlarged, especially both dorsal and ventral setae of the 7th abdominal segment are very prominent (Fig. 8, B6). This form is similar to *Acanthaspidiotus borchsenii*. Intermediate individuals (Fig. 8, B2-B5) connect these extremes into an indivisible

series.

Some specimens collected in Japan (C) are, as a whole, similar to the *persearum*-form, having well-developed 2nd lobes; the 3rd lobes are also well developed, but sometimes replaced by plate-like processes (Fig. 8, C).

Other specimens from Japan (D) and all the examined specimens from Nepal (F) represent *Acanthaspidiotus borchsenii* and are fairly uniform except for the 3rd lobes, which are somewhat variable in size and shape. This form is characterized by having very prominent median lobes, tubercular 2nd lobes, much reduced 3rd lobes, and much enlarged marginal setae (Fig. 8, D and F). The single specimen from Yaku-Sima, Japan, (E) is similar to this form, with the 3rd lobe replaced by a membraneous process on either side.

The specimens from Tenerife (H) are also similar to *Acanthaspidiotus borchsenii*, but the 2nd lobes are less tubercular, membraneous, and more or less narrowed towards the apex, and the 3rd lobes are plate-like (Fig. 8, H).

The single specimen available from Turkey (G) is similar to the *persearum*-form, having well-developed 2nd lobes (Fig. 8, G).

The plates occurring outside the 3rd lobes are also somewhat variable in shape and development, but it does not seem that the variation of these plates is correlated with that of the lobes or the marginal setae. The sclerotization extending from the bases of the median lobes are usually clearly seen, but sometimes very obscure in specimens with well-developed 2nd lobes (Fig. 8, B1 and C).

The specimens examined are also variable in the numbers of the dorsal macroducts and perivulvar disc pores (Table 1). When these numbers are plotted on a scatter diagram (Fig. 3), the specimens from America, excluding those from the type-series of *Aspidiotus spinosus*, seem to form one group. The specimens from the type-series are in so poor condition that their macroducts could not be counted; in the number of the perivulvar disc pores they do not seem to deviate from the American group.

The specimens from Tenerife fall within the range of the American group. On the other hand, *Acanthaspidiotus borchsenii*, represented by the part of the type-series and the specimens from Nepal, appears to form another group. This pattern is, however, obscured when further specimens from Japan (C) are added to the scatter diagram. These specimens, while approaching the *persearum*-form in the marginal features of the pygidium, are rather irregularly scattered around *Acanthaspidiotus borchsenii*.

The observations are summarized as follows. So far as the characters of the pygidial margin are concerned, the specimens form a continuous series of variation ranging from the *persearum*-form to *Acanthaspidiotus borchsenii*. This suggests that all the varying forms belong to a single species. This view is not definitely supported by the correlation between the numbers of the dorsal macroducts and perivulvar disc pores. In this correlation the specimens are divided into 2 groups, which agree with geographical divisions but not necessarily with the characters of the pygidial margin. Under these circumstances the view may be adopted that all the forms belong to a single species, which, however, comprises geographical races. This view, which is a compromise rather than a conclusion, is to be criticized on the basis of futher abundant material. This species as understood here may be described as follows:

Recognition characters (adult female). Median lobes moderately large to very prominent, usually with a distinct subapical notch on each side; a well-developed basal sclerotization usually clearly seen. Second lobes varying in size and shape: in one extreme well developed, expanded towards apex, with a subapical notch on each side, while in the other extreme reduced to a tubercular prominence; there are various intermediates between these extremes. In general the 3rd lobes are well developed in individuals with well-developed 2nd lobes, and membraneous and variously deformed in individuals with ill-developed 2nd lobes. Dorsal marginal setae of 5th-7th abdominal segments and ventral marginal seta of the 7th more or less enlarged, and especially both dorsal and ventral setae of the 7th sometimes quite prominent; there is a tendency of larger marginal setae to be associated with reduced 2nd and 3rd lobes. Two plates between median lobes slender, little fringed; 2 plates between median and 2nd lobes fringed, at most only slightly extending beyond apices of median lobes; 3 plates between 2nd and 3rd lobes fringed, the mesalmost more or less smaller than the lateral two; about 5-6 plates occurring outside 3rd lobe, spiniform or variously laciniate. Number of dorsal macroducts, see Table 1; 1 marginal macroduct present between bases of median lobes. Lateral macroducts on 2nd and 3rd, and sometimes also 1st, abdominal segments, 4-13 in total on one side of body. Perivulvar disc pores present in 4 groups (Table 1). Prepygidial region of body with ventral microducts scattered broadly along body margin and submedially on abdomen, and with much shorter dorsal microducts along body margin.

Remarks. It is the opinion tentatively adopted that *Aspidiotus spinosus* and *Acanthaspidiotus borchsenii* belong to the same species. The generic position of this species, then, may be open to question. This species is no longer retainable in *Aspidiotus* on account of the following characters: the dorsal and ventral marginal setae occurring on the base of the 2nd lobe are sometimes remarkably enlarged; the pygidial macroducts are too small for an *Aspidiotus* species and with a sclerotized rim around the orifice; the plates occurring outside the 3rd lobes are fleshy and often not fringed; and the anal opening is situated too close to the apex of the pygidium. It agrees with the type-species of *Acanthaspidiotus* in having enlarged marginal setae and small dorsal macroducts, but differs from the latter in the anal opening situated subapical, the plates not of such a bifurcate type as found in that genus, and the mesalmost row of pygidial macroducts ending quite short.

On the other hand, this species has some characters in common with *Octaspidiotus araucariae* and *O. caledonicus* as stated under *Oceanaspidiotus*. In general characters it is very similar to *O. caledonicus* in spite of the different position of the anal opening, the absence of the 4th pair of lobes, and the presence of perivulvar disc pores. The last of these characters is often no more than specific in the Diaspididae, and the 2nd is also interpreted as merely specific (see the next section). Upon all these considerations this species may tentatively be grouped together with *O. caledonicus* and also *O. araucariae*, thus belonging to *Oceanaspidiotus*.

Occurrence of fourth lobes in Octaspidiotus, Oceanaspidiotus, and Aspidiotus

In the Aspidiotini the occurrence of as many as 4 pairs of lobes is limited to a

relatively small number of species. Considerable weight has been attached to the number of lobes as well as to their state in the generic classification of the Diaspididae. Thus, *Octaspidiotus caledonicus* was once grouped together with *O. araucariae* and *O. subrubescens* in the same genus for the reason that they have 8 lobes, and not with the 6-lobed *Aspidiotus spinosus* in spite of the fact that *O. caledonicus* and *A. spinosus* have many general characters in common.

The pygidial lobes are not such a discrete structure as a jointed organ, so that reduced lobes may merge into the pygidial margin in such a way that there is no boundary between their presence and absence. In some cases the varying lobes may be described either as modified into a membraneous process or replaced by a plate. Further, in some species the variable nature of the lobes is now well known. Sometimes the lateral lobes may be sclerotized and distinct in some individuals, while membraneous and confused with neighbouring plates in others of the same species. Even if the lobes appear to be present in a definite and stable number, there is no *a priori* basis to give special weight to this particular property. Principally, in forming taxa, any property should be evaluated in terms of its association with other properties. In fact, no sufficient reason has been found for separating 8-lobed and 6-lobed species into *Octaspidiotus* and *Metaspidiotus*. *Oceanaspidiotus* in the composition adopted comprises species of both types.

However, the number of lobes itself must have an evolutionary significance. The segments composing the pygidium may plausibly be supposed to have originally been homogeneous as exemplified to some degree by *Parlatoria*, and there may have been a trend to reduction of lateral lobes in accompany with the advance of pygidial reorganization. If this view is right, the occurrence of the 4th lobes is a primitive character in comparison with their absence. *Octaspidiotus subrubescens*, differing from the other species referred to the genus in having distinct 4th lobes, is deemed to be primitive in other characters, too, and to represent a stage primitive to all the other species. The composition of *Oceanaspidiotus* is tentative, so that no further discussion on the relationship among the included species may be useful now.

By the courtesy of Dr. Matile-Ferrero I have had the opportunity to examine 3 aspidiotine species collected in New Caledonia. They all have 4 pairs of lobes, but otherwise cannot be excluded from *Aspidiotus* as currently understood. One of them [# 5496 in the collection of the Muséum National d'Histoire Naturelle, Paris] shows striking resemblance to *A. hederae* (=*A. nerii*) (Fig. 19), while another [# 6917] is similar to *A. destructor* (Fig. 19). The remaining New Caledonian species [# 5554] is peculiar by the combination of short macroducts (as in *A. hederae*) with an apically recessed pygidium (as in *A. destructor*). Parallel evolution may be invoked to explain the resemblance between the species # 5496 and *A. hederae* and between the species # 6917 and *A. destructor,* but it seems more plausible, on account of the agreement in many characters (especially in the 1st pair of species), that these New Caledonian species are really closely related to *A. hederae* and *A. destructor,* respectively, representing or approximating the ancestral forms of the latter two. (In that case, the speciation of *Aspidiotus* should have primarily proceeded in 8-lobed forms.) In no other characters, however, all these New Caledonian species appear to be particularly primitive in comparison with the 6-lobed species.

The genus *Aspidiotus* has one centre of distribution in East to South Asia (Ferris, 1941) and another centre in Africa south of the Sahara (Balachowsky, 1956).

The Asian and African species are, so far as known, all with 3 pairs of lobes, while the 8-lobed New Caledonian species occur at the eastern border of the distribution range of the genus. The genus *Octaspidiotus* is now represented by the 6-lobed species scattered in Asia and the 8-lobed type-species occurring in Australia. In *Oceanaspidiotus* the 2 species with 4 pairs of lobes are very probably native to New Caledonia (and/or Norfolk Is.), while *O. spinosus,* with 3 pairs of lobes, is widely distributed over the world. Thus, in all these genera the 8-lobed species are limited to the zoogeographical division Notogaea (Australia and neighbouring islands). This agreement may not be a mere coincidence, because these aspidiotines with 4 pairs of pygidial lobes are deemed to be relics and Notogaea is known for the occurrence of abundant archaic organisms. This is, however, not unsurprising, because the Aspidiotini are the most advanced group of the Diaspididae so far as their body organization is concerned.

Acknowledgements

I wish to thank Dr. J.W. Beardsley, University of Hawaii, for the loan of specimens of *Aspidiotus araucariae* collected by himself.

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I am grateful to Dr. D. Matile-Ferrero, Muséum National d'Histoire Naturelle, Paris, who gave me the opportunity to examine specimens of *Octaspidiotus caledonicus* and other aspidiotines.

To Mr. S. Nakahara, USDA, I owe not only a great number of specimens but also valuable information.

Thanks to Mr. R. Schuster, University of California, Davis, I have been able to examine *Aspidiotus nothopanacis*.

I am also grateful to Dr. D.J. Williams, Commonwealth Institute of Entomology, for helpful advice and valuable information.

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(Other than given under genera and species)

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Addendum

Metaspidiotus yunnanensis

Tang and Chu, 1983, Acta Zootaxonomica Sinica 8(3) : 304, 306 [Vicinity of Kunming, Yunnan, China, on the needles of *Keteleeria evelyniana* ; compared with *M. multipori*].

The description and figures clearly indicate that this species belongs to *Metaspidiotus* and, therefore, to *Octaspidiotus*. It does not seem to be close to *O. multipori*, however.

TABLES

Table 1. Numbers of pygidial dorsal macroducts and perivulvar disc pores in adult female *Octaspidiotus* and *Oceanaspidiotus* species. Range, mean (in parentheses), and sample size (in brackets) are given.

Species and material	Pygidial dorsal macroducts, total number	Perivulvar disc pores			
		Median	Antero-lateral	Postero-lateral	Total
Oct. subrubescens					
Queensland, Australia *Caelebogyne*, etc.	69- 89 〔6〕	0 1 2 (16) 〔2〕 〔2〕	7-18 (12.9) 〔36〕	5-13 (8.0) 〔38〕	32-54 (42.9) 〔16〕
Oct. calophylli					
A* Nilgiri, India *Neolitsea* (?) 〔78 IND-199〕	63- 89 (77.5) 〔23〕	0 1 2 〔24〕 〔4〕 〔1〕	9-19 (13.5) 〔58〕	6-12 (8.2) 〔58〕	33-48 (43.6) 〔29〕
B* Nilgiri, India *Maesa* (?) 〔78 IND-207〕	75-101 (87.1) 〔29〕	0 1 2 〔25〕 〔4〕 〔1〕	10-20 (14.3) 〔60〕	4-12 (8.6) 〔60〕	34-54 (46.0) 〔30〕
C Nilgiri, India *Symplocos* 〔78 IND-235〕		0 〔1〕	12 14 〔2〕	10 10 〔2〕	46 〔1〕
Oct. stauntoniae					
A* Tôkyô, Japan *Aucuba*	56- 77 (68.9) 〔30〕	0 1 〔29〕 〔1〕	2- 6 (3.9) 〔57〕	3- 7 (5.1) 〔57〕	15-21 (17.9) 〔30〕
B* Nati, Japan *Hedera*	54- 81 (69.1) 〔30〕	0 1 〔27〕 〔3〕	2- 6 (4.1) 〔59〕	3- 7 (4.8) 〔59〕	15-23 (17.9) 〔30〕
C* Matuyama, Japan *Aucuba*	57- 71 (64.0) 〔30〕	0 1 〔29〕 〔1〕	3- 6 (4.4) 〔60〕	3- 6 (4.8) 〔60〕	16-22 (18.5) 〔30〕
D* Tusima Is., Japan *Lindera*	58- 79 (69.6) 〔8〕	0 〔8〕	2- 5 (3.6) 〔16〕	4- 6 (4.9) 〔16〕	14-19 (17.1) 〔8〕
E Kyûsyû, Japan *Aucuba, Skimmia*	60- 77 (68.5) 〔10〕	0 1 〔11〕 〔1〕	2- 6 (3.9) 〔24〕	3- 7 (5.1) 〔24〕	16-21 (18.0) 〔12〕
F Amami-Ôsima, Tokunosima, Japan *Citrus*, an undet. plant	66 76 76 〔3〕	0 〔3〕	3- 4 〔6〕	4- 6 〔6〕	15 17 17 〔3〕
G* Hengchun, Taiwan *Hibiscus*	63- 75 (68.6) 〔8〕	0 〔9〕	2- 4 (3.3) 〔18〕	3- 6 (4.3) 〔18〕	13-17 (15.2) 〔9〕
H Foochoo, Shanghai, Hainan *Aleurites*, etc.	41- 81 (66.0) 〔12〕	0 1 〔12〕 〔1〕	2- 5 (3.3) 〔26〕	3- 5 (4.0) 〔26〕	10-18 (14.6) 〔13〕
I Philippines *Chrysomphyllum*, etc.	57- 72 (65.1) 〔6〕	0 〔9〕	1- 4 (2.5) 〔15〕	3- 5 (4.1) 〔16〕	10-17 (13.0) 〔8〕
Oct. tripurensis					
A* Agartala, India *Thevetia*	54- 65 (57.4) 〔9〕	0 1 〔8〕 〔1〕	10-15 21 (13.7) 〔18〕	6-14 (9.3) 〔18〕	43-49 60 (46.2) 〔9〕
B Thailand *Ficus*	60 〔1〕	0 〔1〕	8 16 〔2〕	9 11 〔2〕	44 〔1〕

Species and material	Pygidial dorsal macroducts, total number	Perivulvar disc pores			
		Median	Antero-lateral	Postero-lateral	Total
Oct. tamarindi					
* Coimbatore, India *Tamarindus*	35- 42 (37.3) 〔7〕	0 3 〔7〕〔1〕	6- 8 (7.4) 〔16〕	3- 5 (3.9) 〔16〕	22-24 (23.0) 〔8〕
Oct. nothopanacis					
Kunming, China *Nothopanax*, *Ternstroemia*	66 68 77 〔3〕	0 〔10〕	6-14 (10.5) 〔20〕	4- 8 (5.5) 〔20〕	27-36 (31.9) 〔10〕
Oct. machili					
* Tai-pei Hs., Taiwan *Schefflera*	53- 65 (59.6) 〔15〕	0 1 〔14〕〔1〕	5-10 (7.6) 〔30〕	3- 8 (4.9) 〔30〕	23-29 (24.9) 〔15〕
Oct. multipori					
A* Mie-ken, Japan *Illicium*	84-104 (97.9) 〔13〕	0 1 〔12〕〔2〕	7-13 (10.4) 〔28〕	7-11 (9.0) 〔28〕	36-43 (39.1) 〔14〕
B* Kagosima-ken, Japan *Skimmia*	83-118 (98.1) 〔60〕	0 1 〔50〕〔11〕	7-15 (10.5) 〔122〕	7-12 (8.8) 〔122〕	32-47 (38.8) 〔61〕
Oct. australiensis					
A Australia, etc. orchids	41- 65 〔7〕	0 〔12〕	6- 9 〔24〕	4- 8 〔24〕	21-32 〔12〕
B* UP, India *Cocculus* leaf 〔78 IND-118〕	58- 67 (62.4) 〔10〕	0 1 3 〔6〕〔4〕〔1〕	5- 9 (7.3) 〔20〕	5- 8 (7.1) (21)	25-31 (28.9) 〔10〕
C* UP, India *Cocculus* branch 〔78 IND-122〕	47- 62 (56.5) 〔8〕	0 1 〔4〕〔6〕	6-10 (8.3) 〔20〕	5- 8 (6.1) 〔20〕	27-32 (29.3) 〔10〕
D* Bagmati, Nepal *Eurya* branch 〔75 NPL-130〕	49- 80 (67.0) 〔24〕	0 1 2 〔20〕〔8〕〔1〕	6-14 (9.7) 〔57〕	4-11 (7.5) 〔57〕	22-41 (34.7) 〔29〕
E* Bagmati, Nepal *Maesa* branch 〔75 NPL-183〕	61- 81 (72.3) 〔28〕	0 1 3 〔19〕〔13〕〔1〕	6-13 (9.7) 〔64〕	5-10 (7.8) 〔64〕	28-40 (35.5) 〔32〕
F* Bagmati, Nepal *Symplocos* branch 〔75 NPL-22〕 (=G)	63- 83 (73.5) 〔32〕	0 1 2 3 〔24〕〔15〕〔2〕〔1〕	5-12 (9.5) 〔86〕	5-11 (8.1) 〔86〕	28-40 (35.7) 〔44〕
G* Bagmati, Nepal *Symplocos* leaf 〔75 NPL-22〕 (=F)	45- 74 (63.0) 〔25〕	0 1 2 〔24〕〔3〕〔1〕	5-10 (8.0) 〔55〕	3-10 (7.1) 〔55〕	22-39 (30.6) 〔29〕
Ocean. araucariae					
Oahu, Hawai *Araucaria*	10 12 17 19 〔4〕				
Ocean. caledonicus					
New Caledonia *Erythrina*	ca. 45-58 〔4〕				
Ocean. spinosus					
A U.S.A. conservatory *Camellia*		0 〔9〕	2- 8 (4.2) 〔18〕	2- 5 (3.6) 〔18〕	11-20 (15.7) 〔9〕

	Species and material	Pygidial dorsal macroducts, total number	Perivulvar disc pores			
			Median	Antero-lateral	Postero-lateral	Total
B	N. & S. America *Citrus*, etc.	22- 33 (27.2) [22]	0 [22]	3- 8 (4.6) [44]	3- 7 (4.3) [44]	12-24 (18.1) [22]
C*	Miyazaki-ken, Japan *Smilax*	32- 45 (37.6) [7]	0 [7]	4- 7 (4.9) [14]	4- 7 (5.1) [14]	16-22 (20.1) [7]
D	Hatizyô Is., Japan *Hydrangea*	33- 52 (43.3) [10]	0 [10]	5- 8 (6.5) [20]	3- 8 (5.9) [20]	20-28 (25.0) [10]
E	Yaku-Sima, Japan *Eurya*	30 [1]	0 [1]	4 5 [2]	4 5 [2]	18 [1]
F	Bagmati, Nepal *Maesa* [75 NPL-176, 183, 194]	32- 49 (38.1) [12]	0 [14]	3- 8 (5.4) [28]	3- 6 (4.7) [28]	16-24 (20.3) [14]
G	Antalya, Turkey *Viburnum*	16 [1]	0 [1]	2 2 [2]	3 3 [2]	10 [1]
H	Tenerife, Canary Is. *Euphorbia*	24- 30 (27.3) [6]	0 [6]	4- 5 (4.6) [12]	2- 5 (3.7) [12]	14-18 (16.5) [6]

Occasional continuous antero— and posterolateral perivulvar disc pores are excluded from the counts for these groups.

*: material probably from a single breeding colony.

Table 2. Frequency of total number of perivulvar disc pores in northern and southern forms of *Octaspidiotus stauntoniae*

Total number of perivulvar pores	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Northern form					1	11	13	21	21	24	13	6	2	1
Southern form	2	1	2	5	4	6	6	3	1					

A-F in Table 1 are lumped together in "northern form", and G-I in "southern form".

Table 3. Some morphoclines constructed for adult female characters of *Octaspidiotus* species and sequence of species in each morphocline.

Morphocline	Sequence of species
I	other spp. → [*calophylli*, *tripurensis*, *stauntoniae*]
II	other spp. → *calophylli* → *tripurensis* → *stauntoniae*
III	other spp. → *multipori*
IV	other spp. → *australiensis*
V	*subrubescens* → other spp.
VI	other spp. → *australiensis*
VII	*subrubescens* → other spp.
VIII	other spp. → *nothopanacis*
IX	other spp. → *tripurensis* → *tamarindi* → *australiensis*
X	other spp. → [*machili*, *multipori*, *australiensis*]

Morphocline I-X, see text; →, polarity.

PLATES

Plate I

Fig. 1. *Octaspidiotus calophylli, O. stauntoniae,* and *O. tripurensis*, adult females: total number of perivulvar disc pores (ordinate) against total number of pygidial dorsal macroducts (abscissa).

●: *O. calophylli*, Nilgiri, India, $n=52$.

○: *O. stauntoniae*, Japan, $n=111$ (Table 1, A-F).

△: *O. stauntoniae*, Taiwan, Foochoo, Shanghai, Hainan, and the Philippines, $n=26$ (Table 1, G-I).

▼: *O. tripurensis*, Thailand, $n=1$.

▽: *O. tripurensis*, Agartala, Tripura, India, $n=9$.

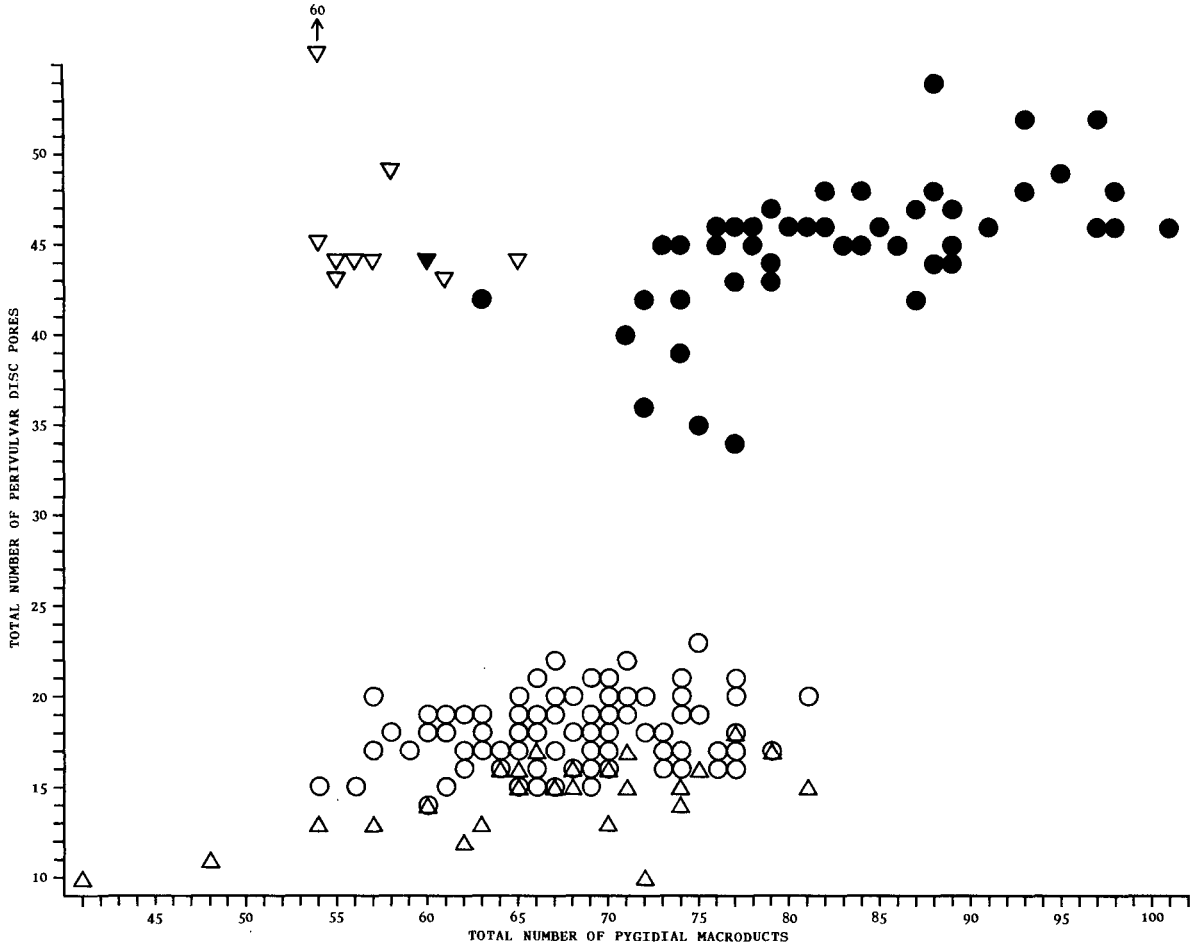

60
TOTAL NUMBER OF PERIVULVAR DISC PORES
10
15
20
25
30
35
40
45
50
45
50
55
60
65
70
75
80
85
90
95
100
TOTAL NUMBER OF PYGIDIAL MACRODUCTS

Plate II

Fig. 2. *Octaspidiotus australiensis*, adult female : total number of perivulvar disc pores (ordinate) against total number of pygidial dorsal macroducts (abscissa).
● : Nepal, on branches, $n=84$.
▽ : Nepal, on leaves, $n=25$.
▲ : Uttar Pradesh, India, on branches, $n=8$.
○ : Uttar Pradesh, India, on leaves, $n=10$.
△ : Australia, New Guinea, Solomon Is., and the Philippines, on orchids, $n=7$.
In bar diagrams are indicated range, mean ($\bar{X}$), 2 standard errors ($2S_{\bar{x}}$) either side of the mean, and 1 standard deviation (S) either side of the mean. For further information, see Table 1 and Material under *O. australiensis*. A-G on the bar diagrams as in Table 1.

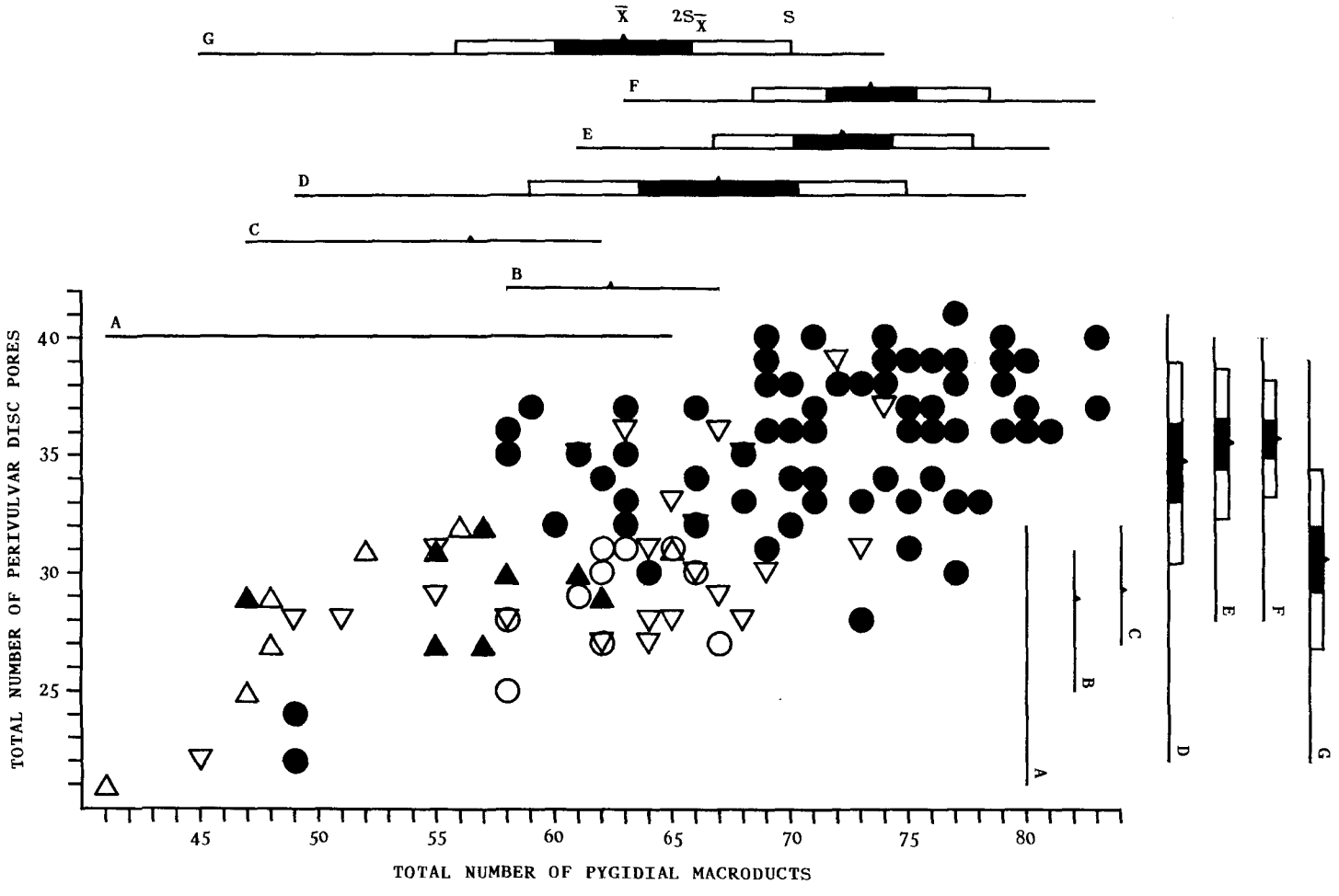

$\bar{X}$
$2S_{\bar{X}}$
S
G
F
E
D
C
B
A
TOTAL NUMBER OF PERIVULVAR DISC PORES
40
35
30
25
45
50
55
60
65
70
75
80
TOTAL NUMBER OF PYGIDIAL MACRODUCTS
A
B
C
D
E
F
G

Plate III

Fig. 3. *Oceanaspidiotus spinosus*, adult female: total number of perivulvar disc pores (X_2) (ordinate) against total number of pygidial dorsal macroducts (X_1) (abscissa).
○: North and South America, $n=22$, $r=0.885$, $X_2=1.31X_1-17.50$.
▲: Hatizyô-zima, Japan, part of type-series of *Acanthaspidiotus borchsenii*, $n=10$.
△: Nepal, $n=12$.
△ and ▲ combined: $n=22$, $r=0.869$, $X_2=0.56X_1-0.06$.
+: Tenerife, Canary Is., $n=7$.
×: Ao-Sima, Miyazaki-ken, Japan, $n=7$.
□: Yaku-Sima, Japan, $n=1$.
●: Antalya, Turkey, $n=1$.
For further information, see Table 1 and Material under *O. spinosus*.

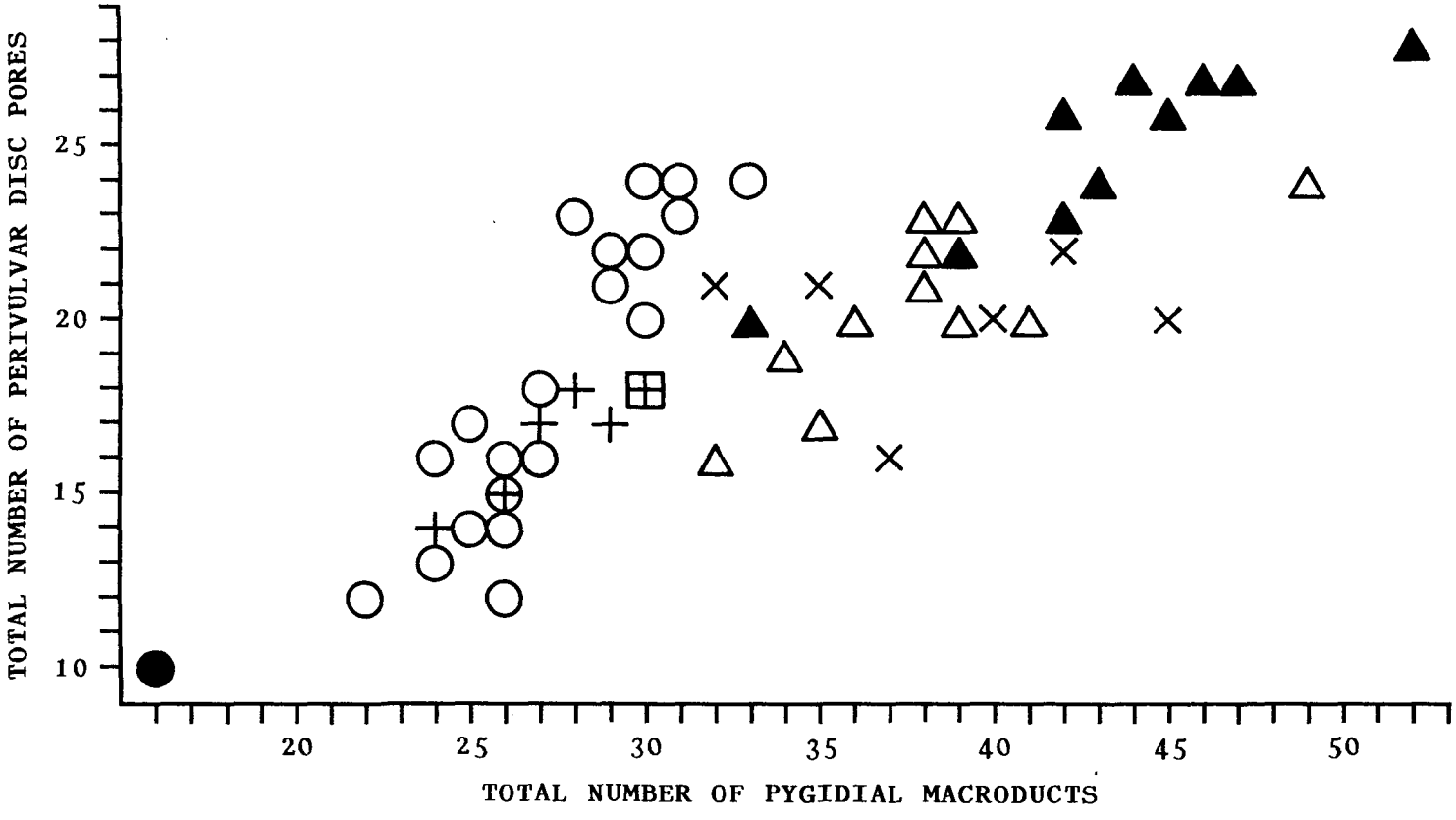

TOTAL NUMBER OF PERIVULVAR DISC PORES
10
15
20
25
20
25
30
35
40
45
50
TOTAL NUMBER OF PYGIDIAL MACRODUCTS

Plate IV

Fig. 4. *Octaspidiotus subrubescens*, adult female. Imbil, Queensland, Australia, on *Caelebogyne ilicifolia*.
Upper : pygidium (scale : 0.1 mm).
Lower : pygidial margin (scale : 0.05 mm).

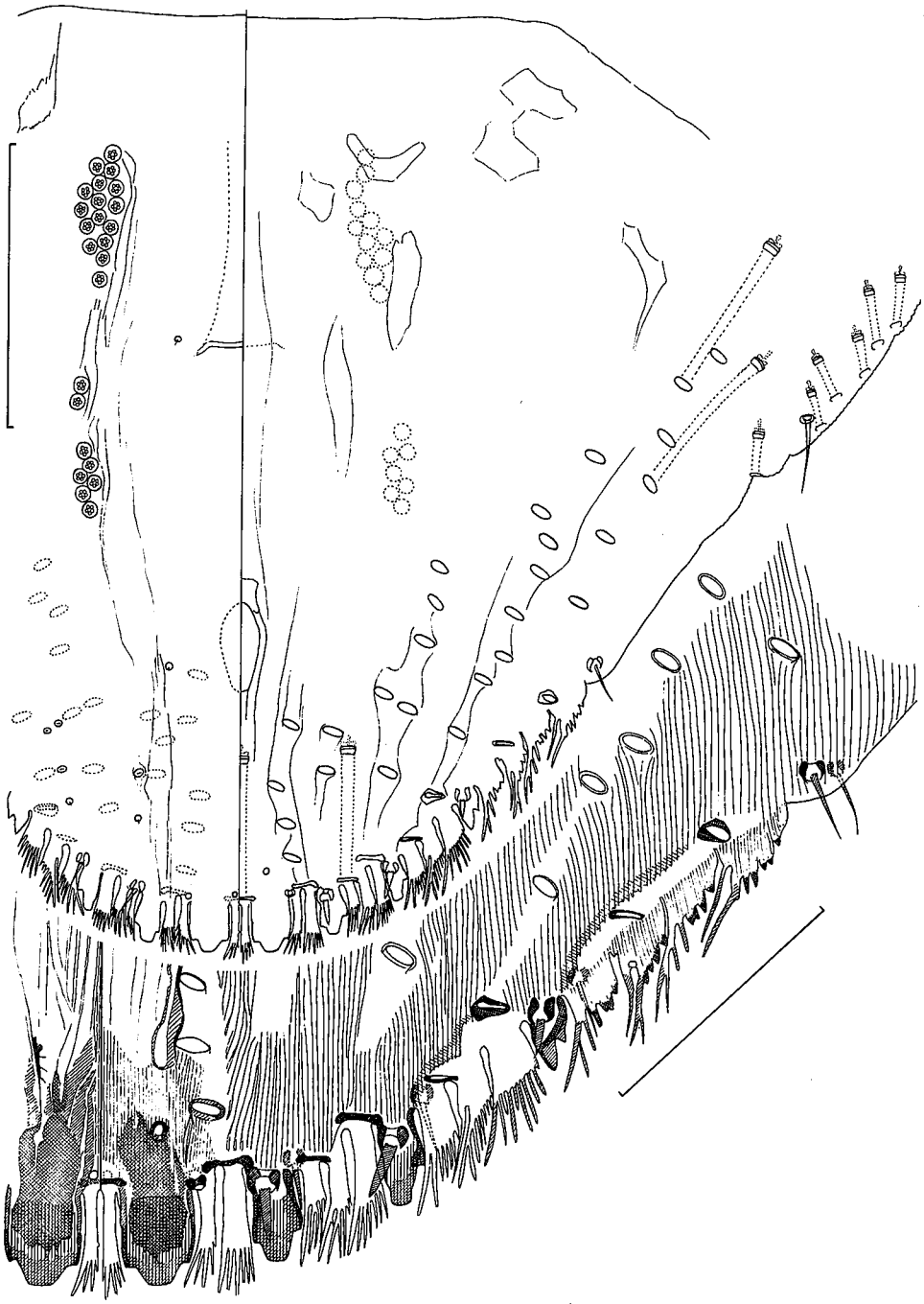


Plate V

Fig. 5. *Octaspidiotus nothopanacis*, adult female. Nr. Kunming, China, on *Nothopanax delavayii*, holotype [in coll. Univ. California, Davis].
Upper: pygidium (scale: 0.1 mm).
Lower: pygidial margin (scale: 0.05 mm).

Plate VI

Fig. 6. *Oceanaspidiotus araucariae*, adult female: pygidium (scale 0.05 mm). Oahu, Hawaii Islands, on *Araucaria excelsa*.

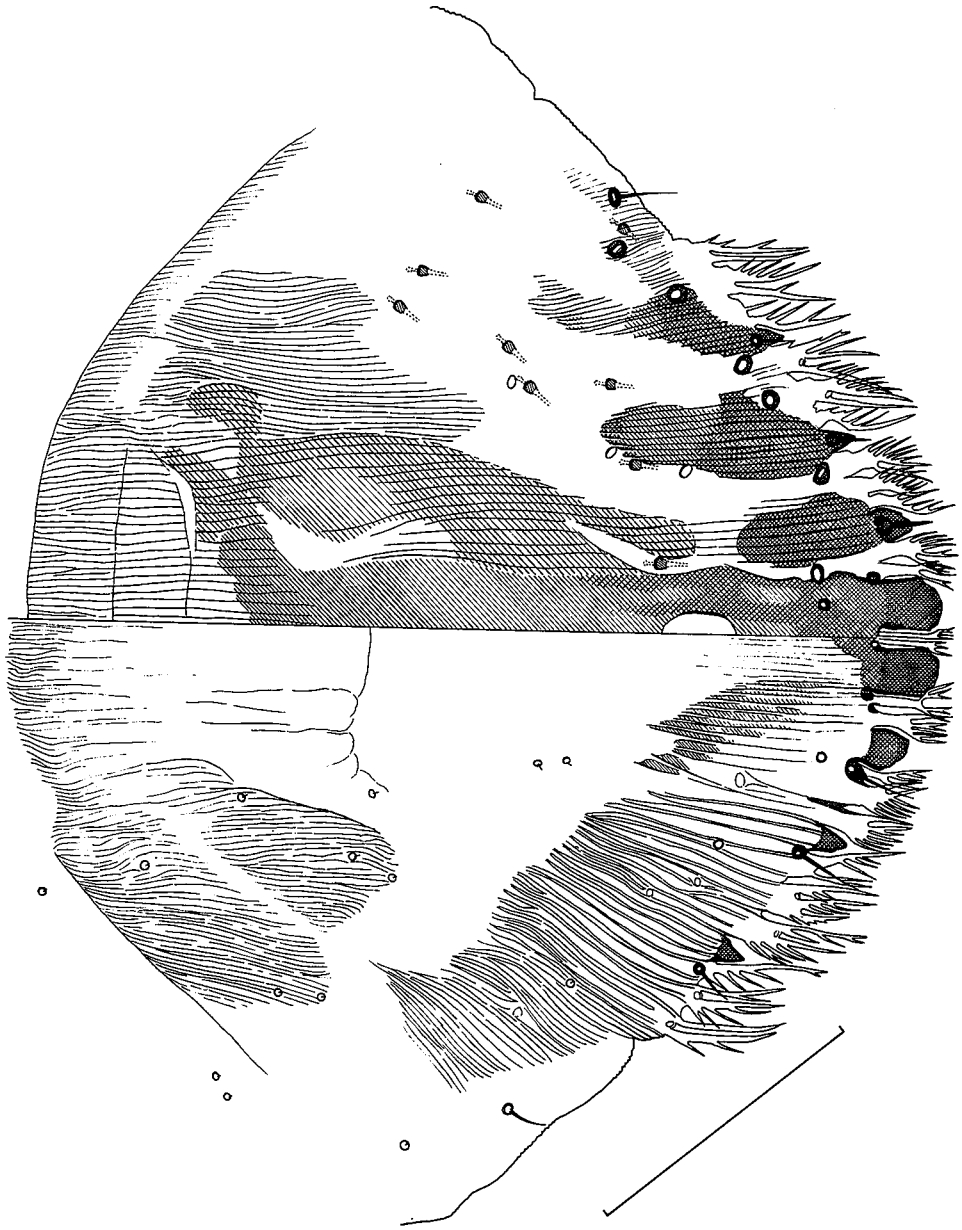


Plate VII

Fig. 7. *Oceanaspidiotus caledonicus*, adult female : variation of pygidial margin (scale : 0.05 mm). Noumea, New Caledonia, on *Erythrina fusca* var. *fustigiata*, type-series [in coll. Muséum Nat. d'Hist. Nat., Paris].

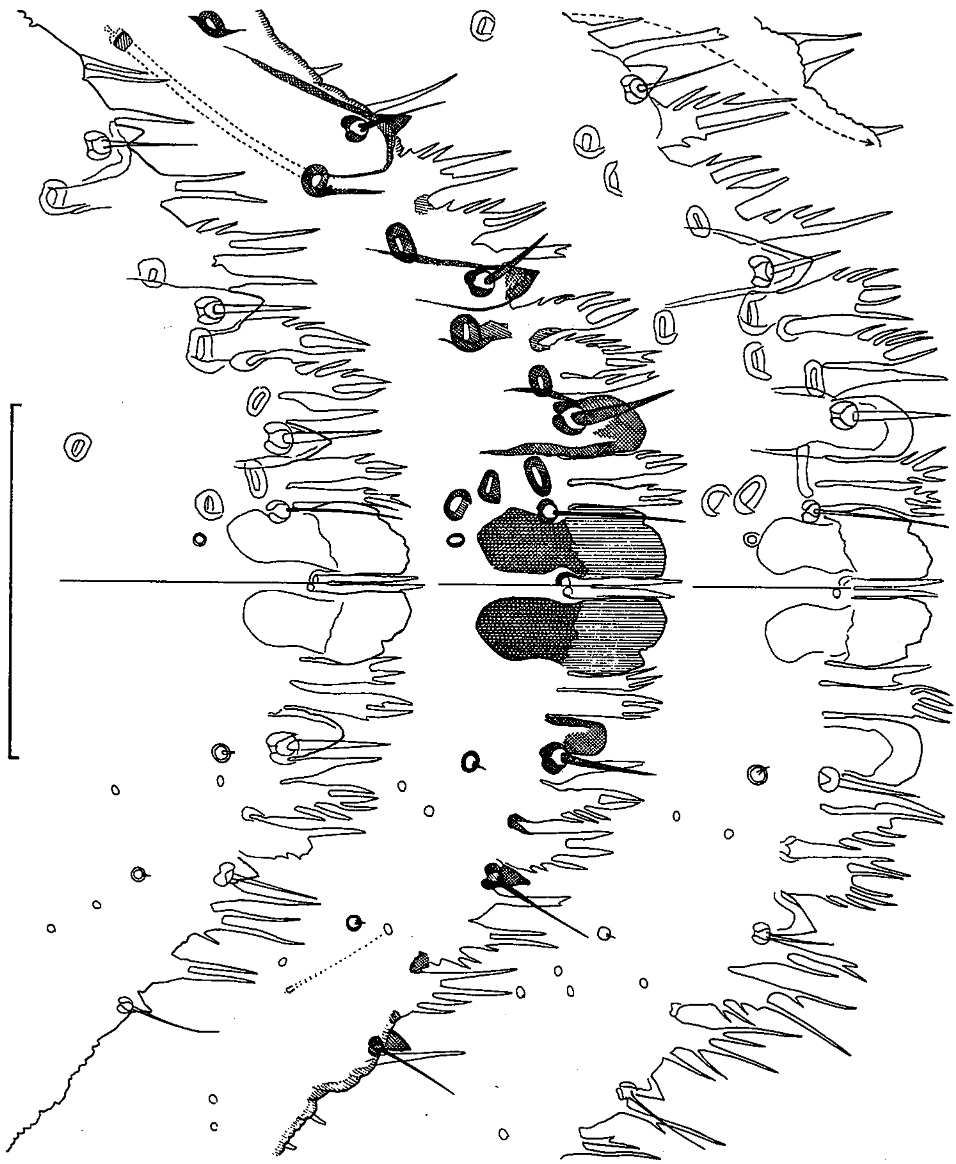


Plate VIII

Fig. 8. *Oceanaspidiotus spinosus*, adult female: variation of pygidial margin in dorsal view (scale 0.05 mm).
B1: Costa Rica, on orchid leaf.
B2, B3: Brasil, on bromeliaceous plant leaf.
B4—B6: Brownsville, Texas, U.S.A., on *Euonymus* stem.
C: Ao-Sima, Miyazaki-ken, Japan, on *Smilax stenopetala* stem.
D: Hatizyô-zima, Idu Is., Japan, on *Hydrangea macrophylla*, type-series of *Acanthaspidiotus borchsenii*.
F: between Betrawate and Ramche, 1370 m, Bagmati, Nepal, on *Maesa macrophylla* branch [75NPL-176].
G: Antalya, Turkey, on *Viburnum*.
H: Tenerife, Canary Is., on *Euphorbia regisjubae*.

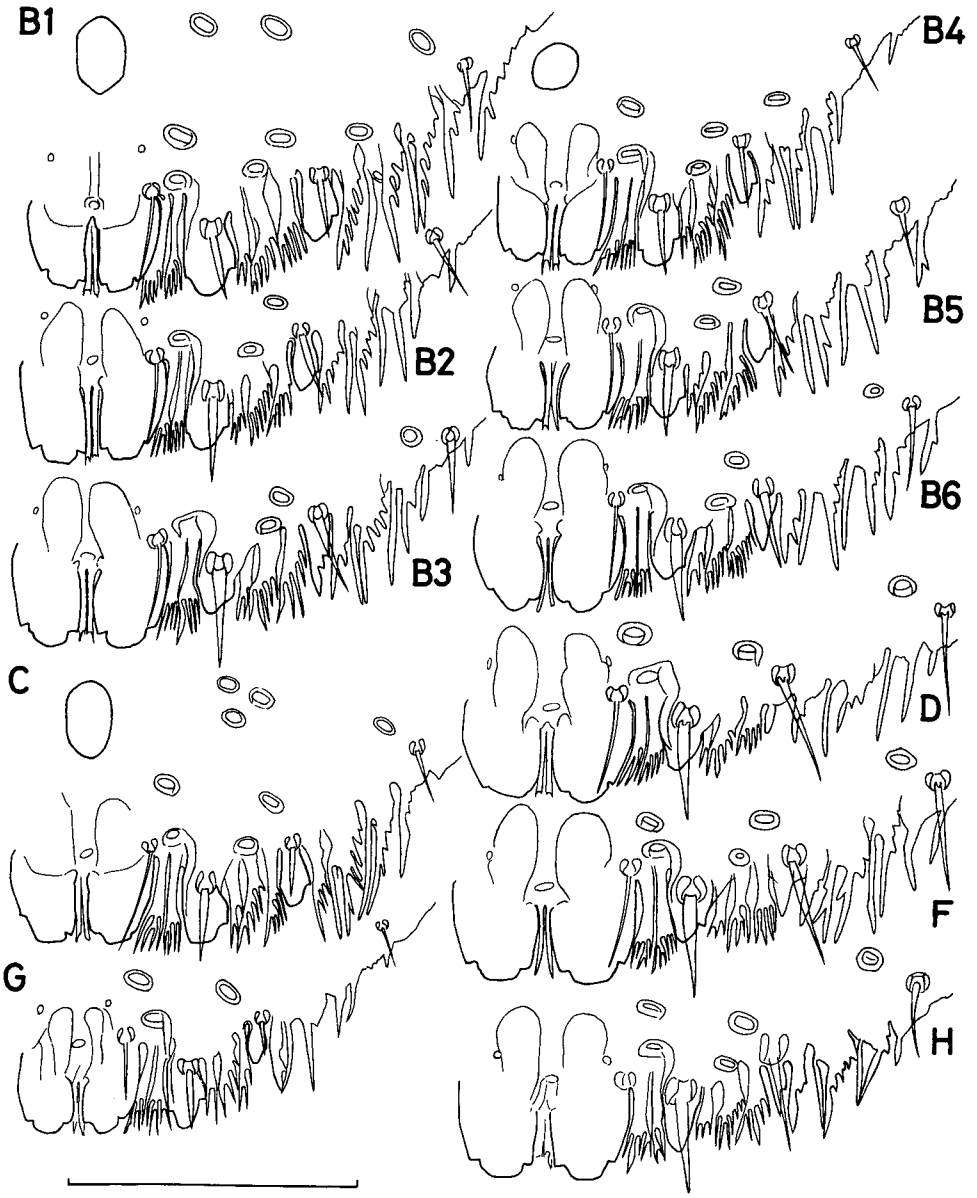

B1
B4
B2
B5
B3
B6
C
D
F
G
H

Plate IX

Fig. 9. *Octaspidiotus calophylli*, adult female. Nr. Coonoor, 1810 m, Nilgiri, India, on a lauraceous plant (*Neolitsea* sp.?) [78IND-199].
Upper : pygidium (scale : 0.1 mm).
Lower : pygidial margin (scale : 0.05 mm).

Plate X

Fig. 10. *Octaspidiotus* spp., adult females: pygidial margins (scales: 0.05 mm).
A: *O. tamarindi*, Coimbatore, Tamil Nadu, India, on *Tamarindus indicus* [78IND-262].
B: *O. machili*, Tai-pei Hsien, Taiwan, on *Schefflera octophylla*.
C: *O. multipori*, Mie-ken, Honsyû, Japan, on *Illicium anisatum*.
D: *O. stauntoniae*, Uwazima, Sikoku, Japan, on *Aucuba japonica*.
E: *O. tripurensis*, Agartala, Tripura, India, on *Thevetia peruviana*, holotype [in coll. Dept. Zool., Univ. Calcutta].

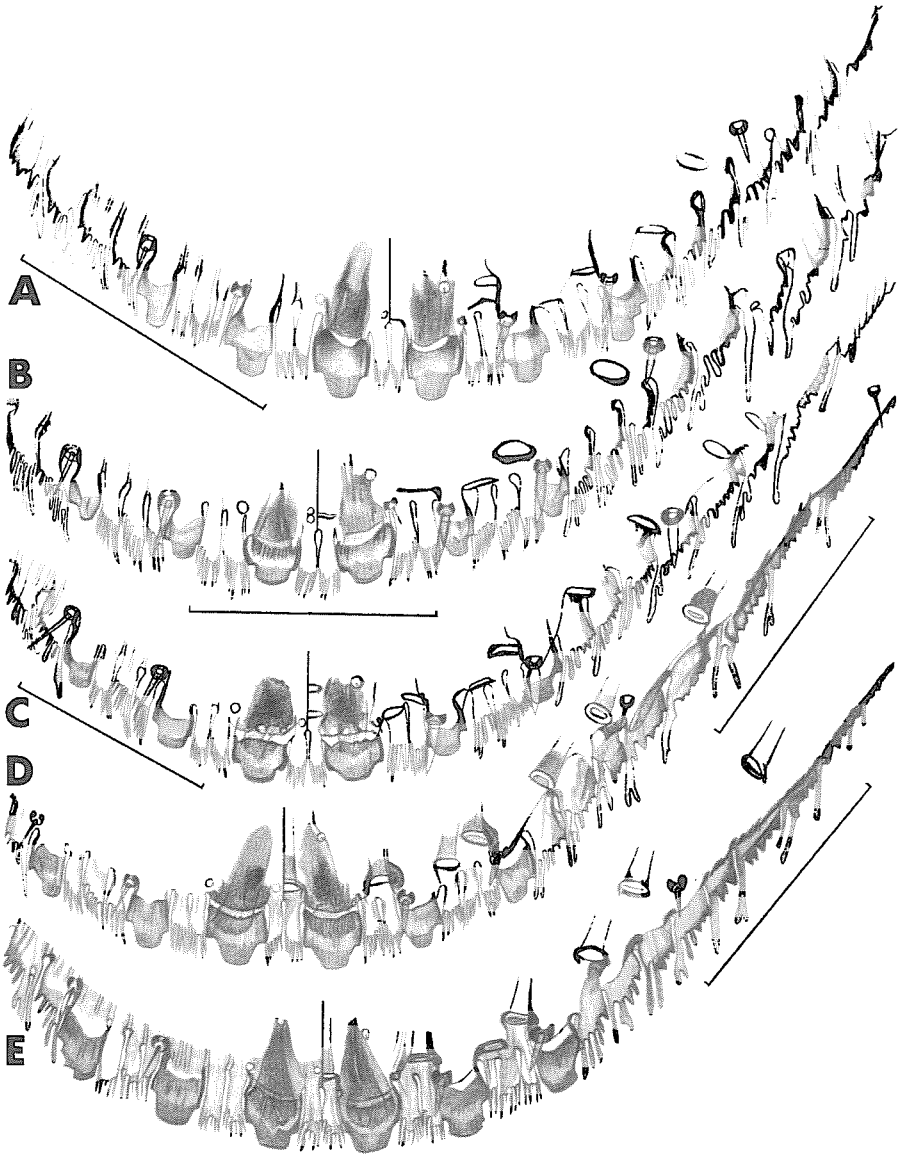

A
B
C
D
E

Plate XI

Fig. 11. *Octaspidiotus australiensis*, adult female : pygidium (scale : 0.1 mm). Sahastradhara, Uttar Pradesh, India, on *Cocculus laurifolius* leaf [78IND-118].

Plate XII

Fig. 12. *Octaspidiotus australiensis*, adult female: pygidium (scale: 0.05 mm). Sheopuri, ca. 1700 m, nr. Kathmandu, on *Eurya* sp. branch [75NPL-130].

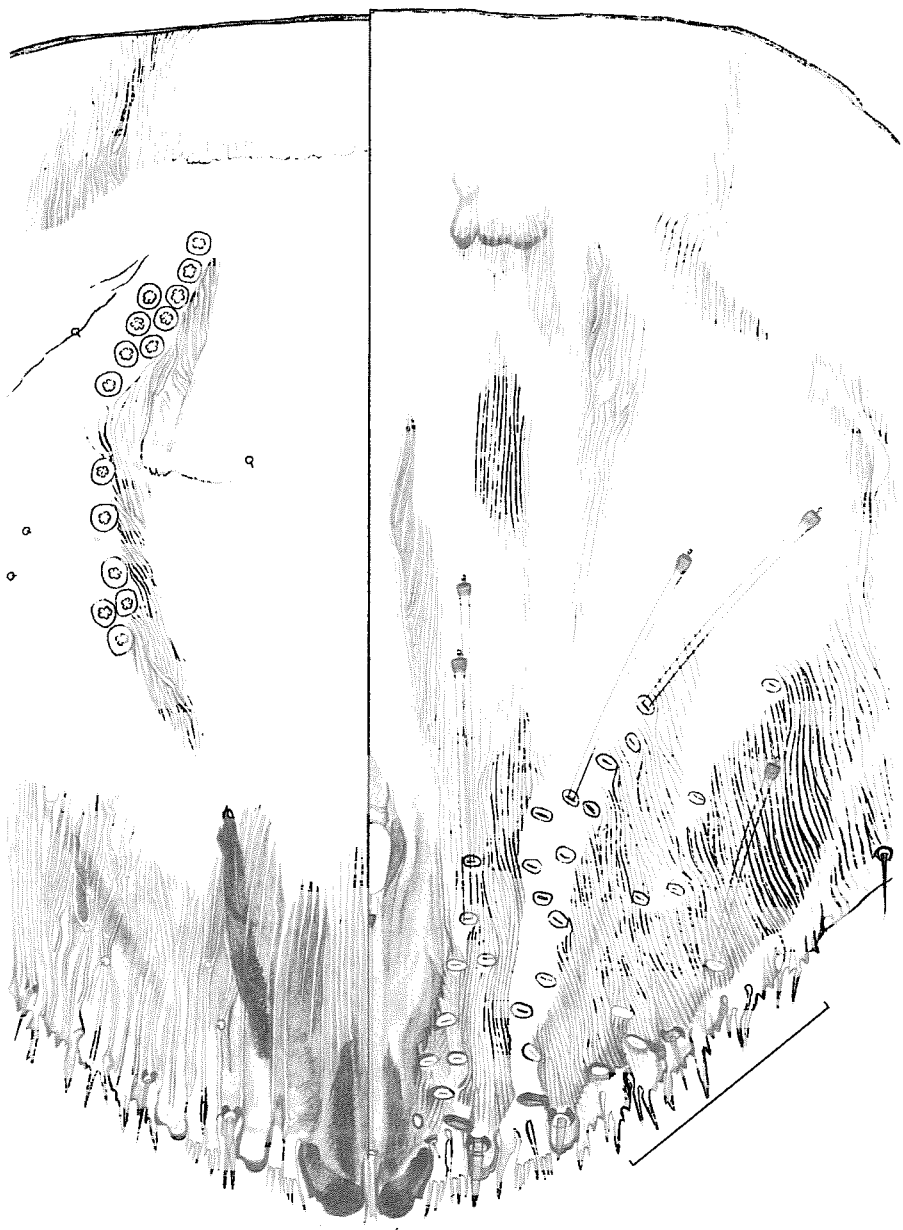
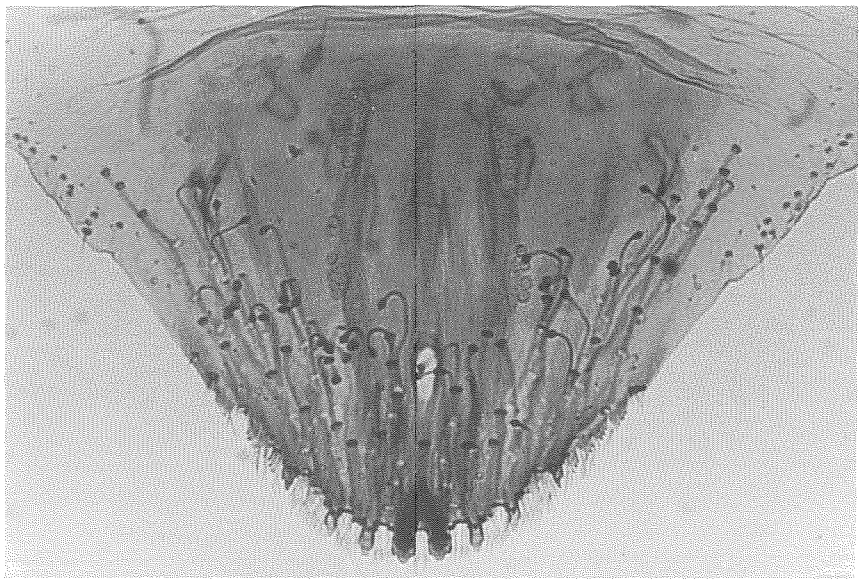


Plate XIII

Fig. 13. Upper: *Octaspidiotus subrubescens*, adult female: pygidium. Imbil, Queensland, Australia, on *Caelebogyne ilicifolia*.
Lower: *Octaspidiotus multipori*, adult female: pygidium. Makizono, Kagosima-ken, Japan, on *Skimmia japonica*.



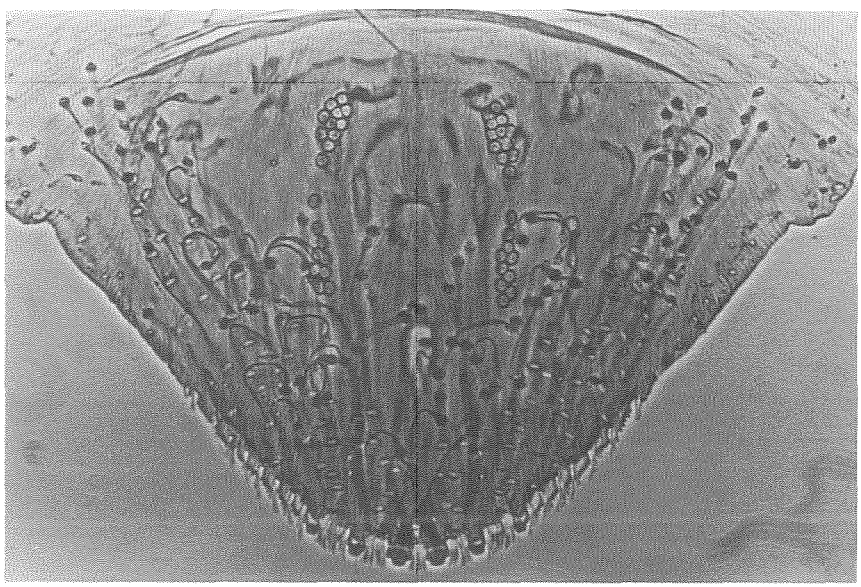
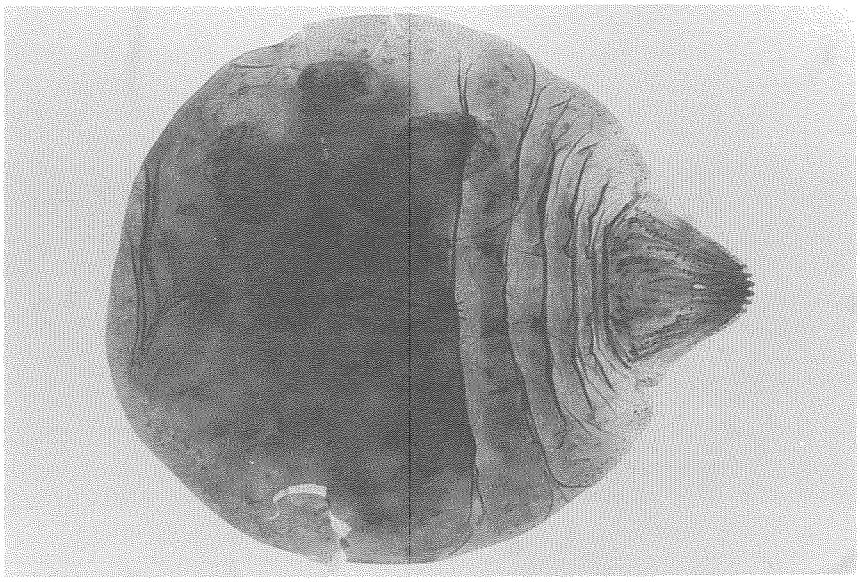


Plate XIV

Fig. 14. *Octaspidiotus calophylli*, adult female at maturity : body (upper) and pygidium (lower). Nr. Coonoor, 1830 m, Nilgiri, India, on *Maesa* sp.? [78IND-207].



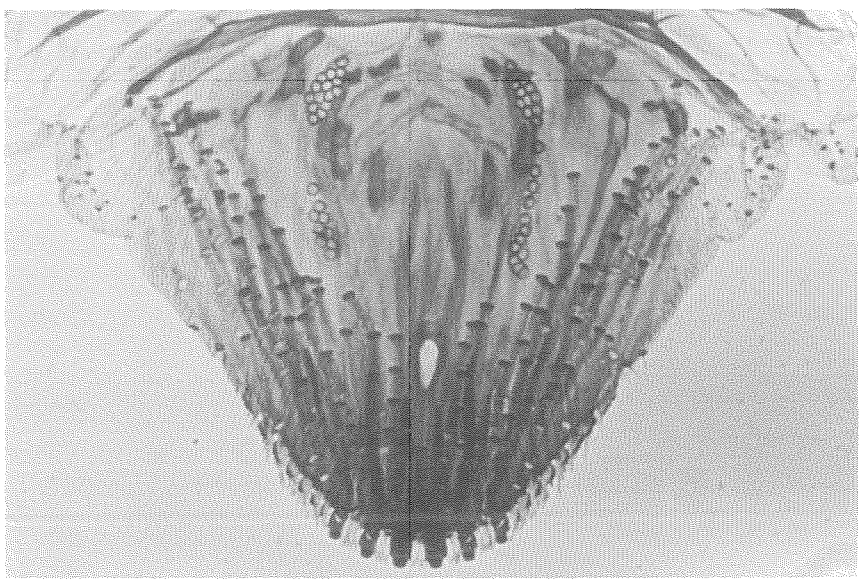
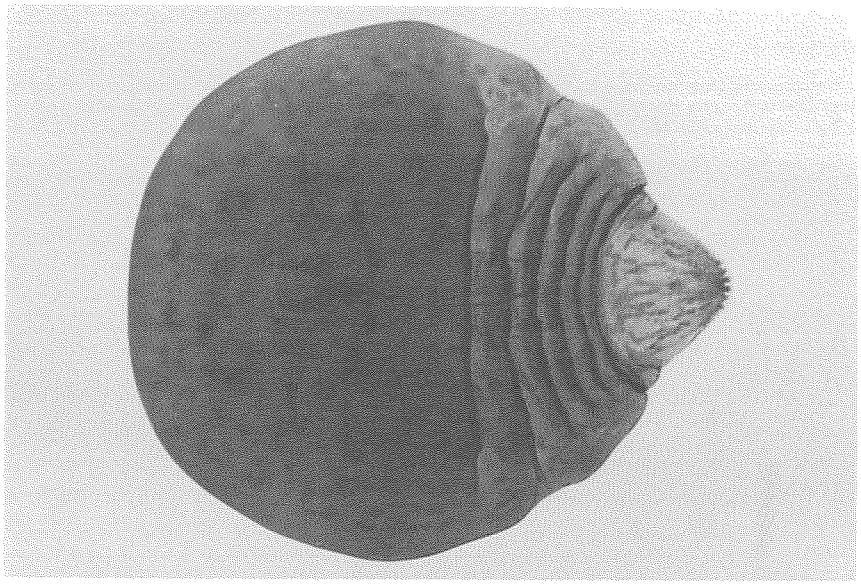


Plate XV

Fig. 15. *Octaspidiotus stauntoniae*, adult female at maturity.
Upper: body. Matuyama, Sikoku, Japan, on *Aucuba japonica*.
Lower: pygidium. Nati, Kii Peninsula, Japan, on *Aucuba japonica*.



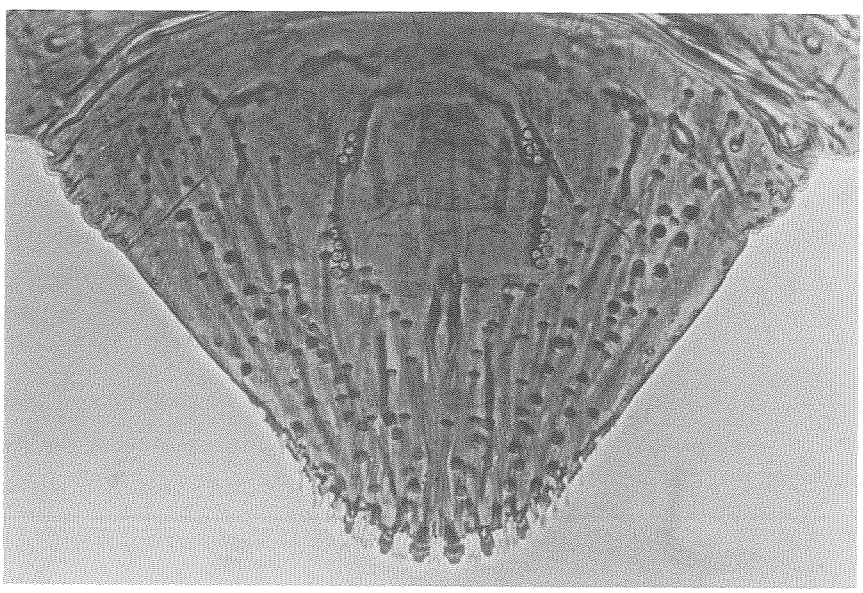
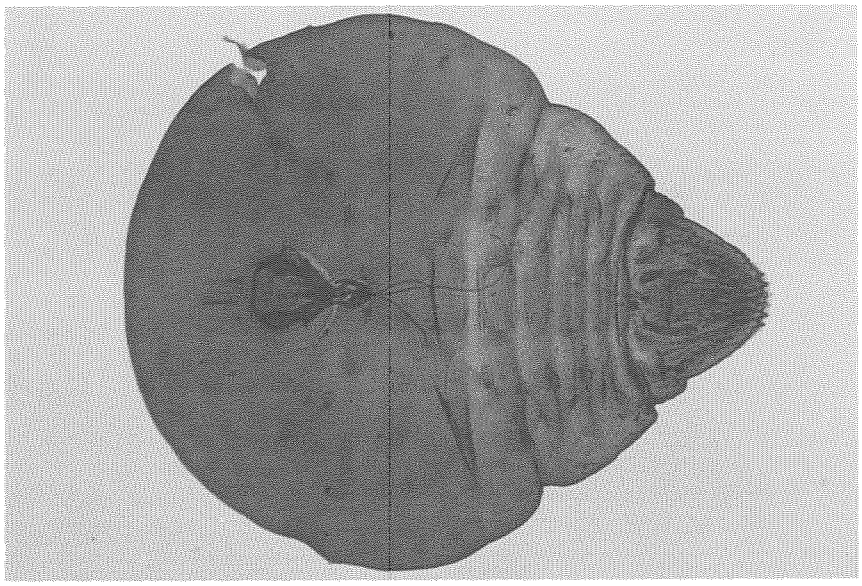


Plate XVI

Fig. 16. *Octaspidiotus tripurensis*, adult female at maturity : body (upper) and pygidium (lower). Thailand, on *Ficus religiosa* [in coll. U.S. Nat. Museum].



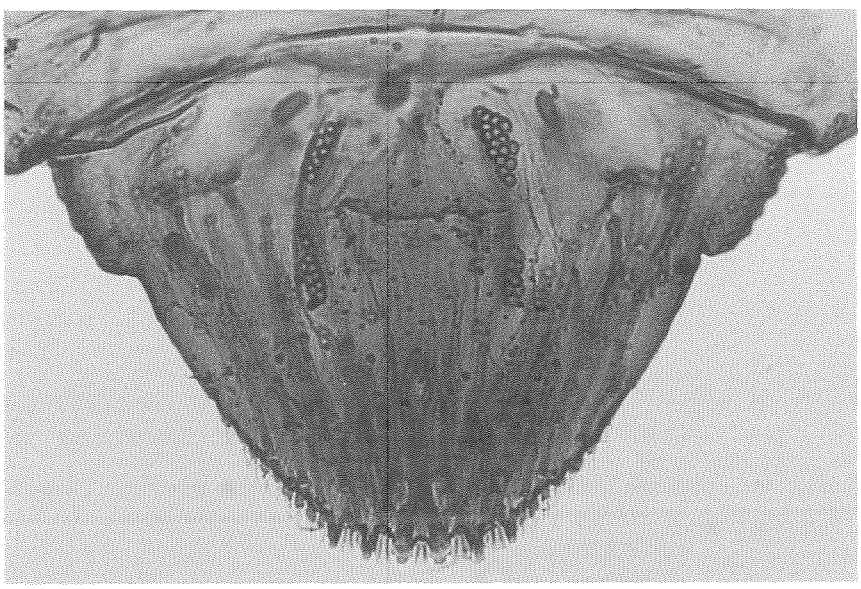


Plate XVII

Fig. 17. Upper: *Octaspidiotus australiensis*, adult female: pygidium. Godavari, ca. 1600 m, nr. Kathmandu, Nepal, on *Symplocos crataegoides* branch [75NPL-22].
Lower: *Oceanaspidiotus spinosus, borchsenii*-form, adult female: pygidium. Between Betrawate and Ramche, 1370 m, Bagmati, Nepal, on *Maesa macrophylla* branch [75NPL-176].

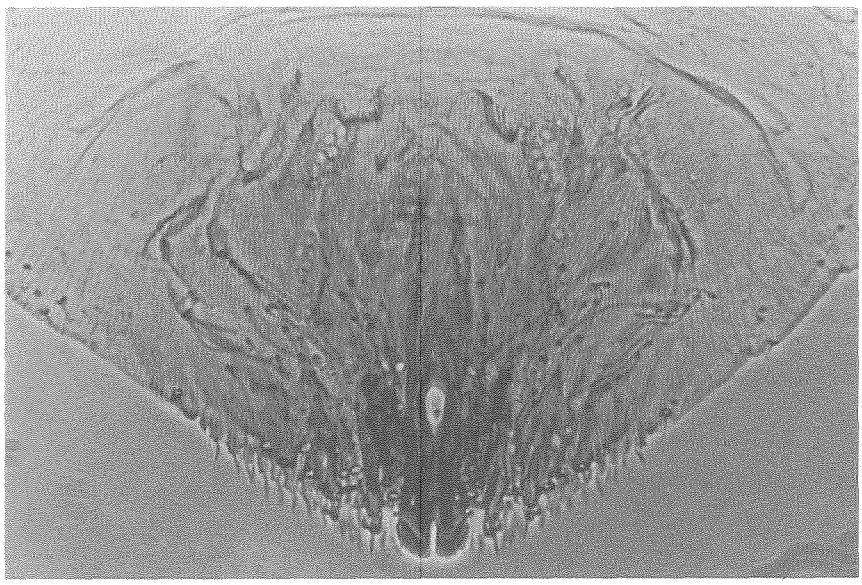
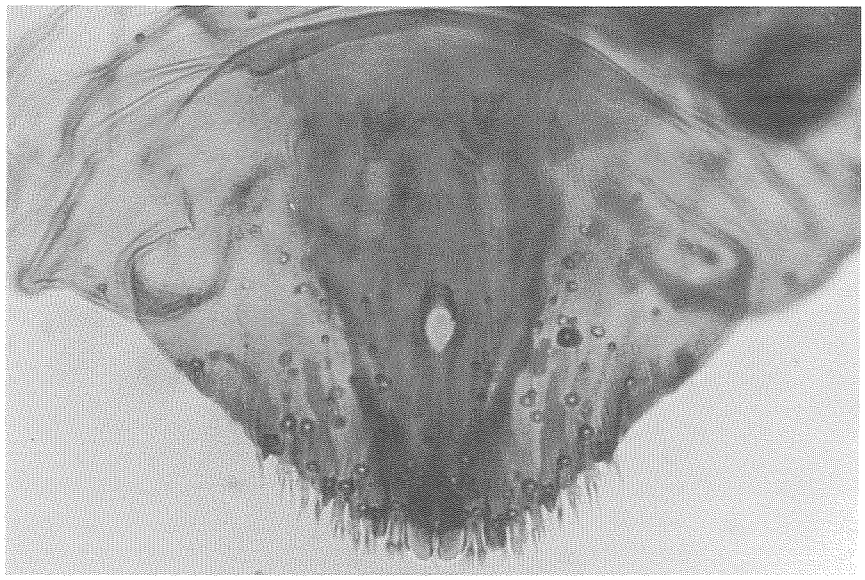


Plate XVIII

Fig. 18. *Oceanaspidiotus caledonicus*, adult female: variation of pygidium. Noumea, New Caledonia, on *Erythrina fusca* var. *fustigiata*, type-series [in coll. Muséum Nat. d'Hist. Nat., Paris].



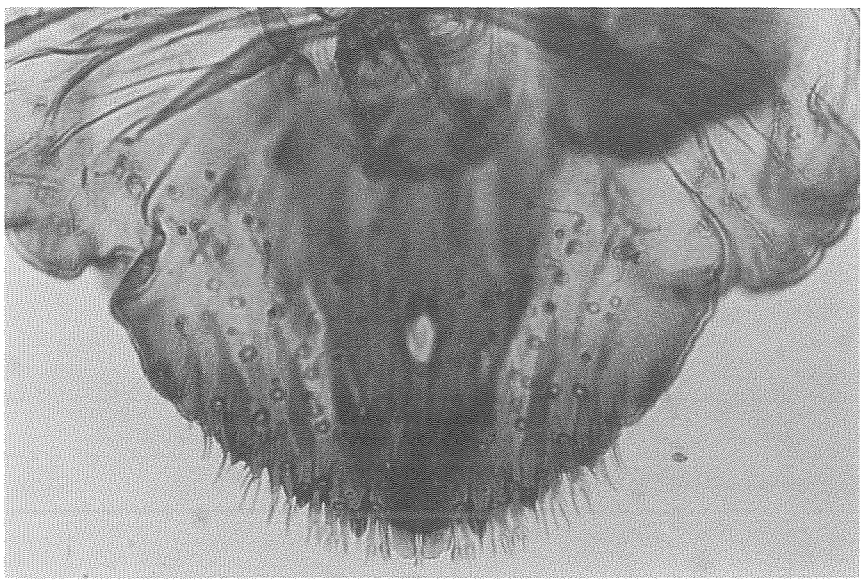


Plate XIX

Fig. 19. *Aspidiotus* spp. with 4 pairs of pygidial lobes, adult female : pygidium.
Upper : Boulinda, New Caledonia, on *Phyllanthus montrouzieri* [in coll. Muséum Nat. d'Hist. Nat., Paris : # 5496].
Lower : Noumea, New Caledonia, on *Avicennia officinalis* [in coll. Muséum Nat. d'Hist. Nat., Paris : # 6917].